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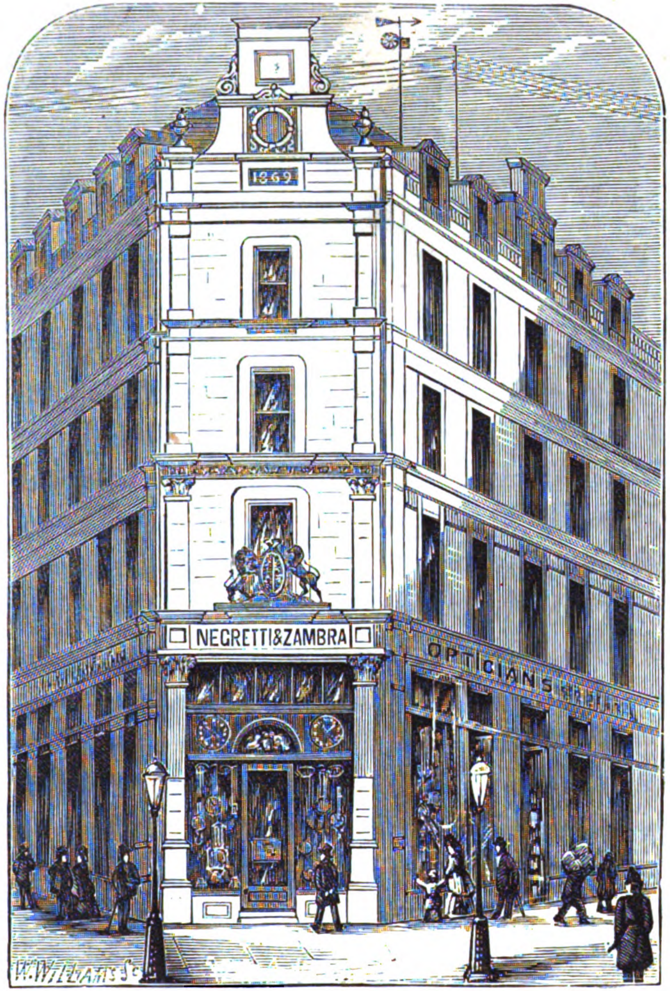

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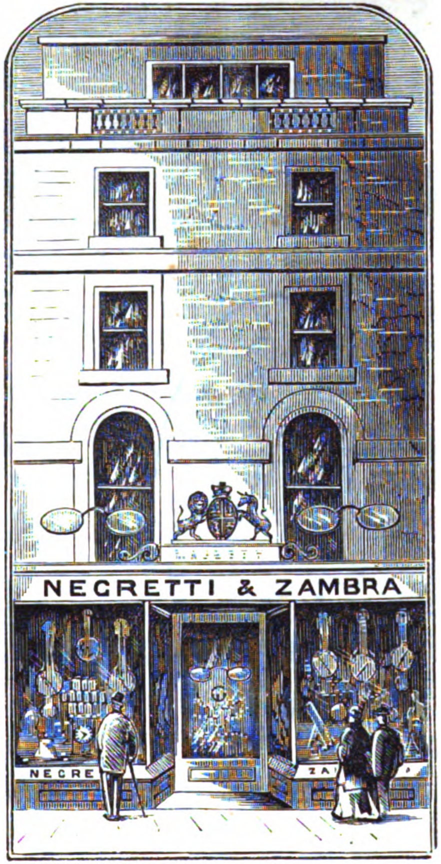

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NEGRETTI & ZAMBRA'S
ENCYCLOPÆDIC
ILLUSTRATED AND DESCRIPTIVE
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CATALOGUE
OF
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AND
STANDARD
METEOROLOGICAL
INSTRUMENTS,
MANUFACTURED AND SOLD BY THEM.

NEGRETTI AND ZAMBRA,

Opticians and Meteorological Instrument Makers to

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H.R.H. THE PRINCE OF WALES;

THE ROYAL OBSERVATORY, GREENWICH; THE ADMIRALTY; HON. BOARD OF ORDNANCE;
BOARD OF TRADE; THE BRITISH METEOROLOGICAL SOCIETY;
THE OBSERVATORIES, KEW, TORONTO, WASHINGTON, VICTORIA; EAST INDIAN GOVERNMENT.

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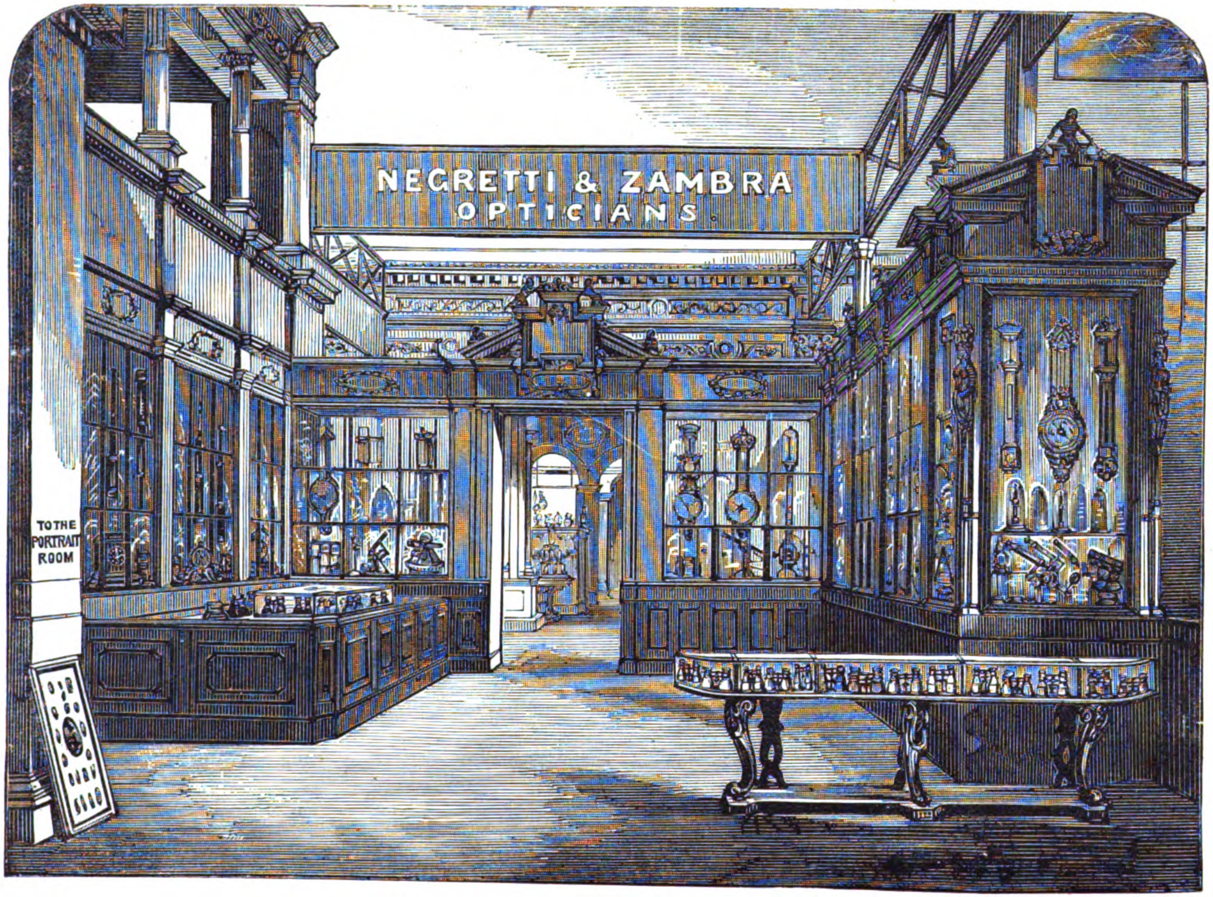


CRYSTAL PALACE, SYDENHAM.

HONORARY AWARDS TO NEGRETTI AND ZAMBRA.

1851. *The only Prize Medal for Meteorological Instruments was awarded to Negretti and Zambra.*

1855. "*Honourable Mention.*"—*Paris Exhibition.*

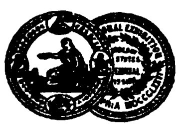
The Kew Committee exhibited among their Apparatus one of our Patent Maximum Thermometers; the Jury awarded an Honourable Mention for this Instrument. Negretti and Zambra not having exhibited at all.

The "*Austrian Gold Medal.*"—*For Stereoscopic Photographic views on Glass.*

1862. *Two Prize Medals.—I. Meteorological Instruments.—The terms of the Award being as follows:—"For many important inventions and improvements, together with accuracy and excellence in objects exhibited."*

II. Photographic Transparencies, "for beauty and excellence of, and adaptation of Photography to Book Illustrations."

1875. *A Prize Medal.—Santiago, Chili, awarded for their exhibited collection of Optical and Physical Instruments.*



1876. *Three Prize Medals,—Philadelphia, "for Meteorological Instruments;" "for Thermometers" and "for Microscopes."*

1878. *A Gold Medal, Paris. The only Gold Medal awarded for Meteorological Instruments in the British Section.*

NEGRETTI AND ZAMBRA'S

INVENTIONS AND IMPROVEMENTS.

Porcelain Scales to Barometers and Thermometers, the divisions being permanently etched or painted thereon; a plan now universally adopted by all makers.

Enamelling the centre or back of Thermometer Tubes. By this invention, Negretti and Zambra have been enabled to make Thermometers at least twenty times more sensitive than heretofore. The delicate Clinical Thermometers now so extensively used could never have been efficiently constructed without the aid of the enamelled tube. *See Sensitive Thermometers, pages* 28 *and* 463.

Negretti and Zambra's Patent Self-Registering Maximum Thermometer. *Pp.* 32 *to* 34. *For a Report on the value of this Thermometer by the Kew Committee see page* 33.

Negretti and Zambra's Patent Self-Registering Maximum Thermometer, specially arranged for obtaining underground temperatures, Mines, Springs, &c., Marine service, Solar Observations, &c., &c. *See pages* 34 *to* 37, 44, 145, *and Addenda.*

Negretti and Zambra's Patent Mercurial Minimum Thermometers (two patents). *See Pp.* 39 *to* 41.

FitzRoy's Marine Gun Barometer, constructed for use in Her Majesty's Navy, by Negretti and Zambra, the only one adopted and in use in Her Majesty's vessels. *See page* 123.

FitzRoy's Storm or Life-Boat Service Barometer. *See page* 120.

Pocket and watch-sized Aneroid Barometer. The first Pocket Aneroid ever produced was manufactured by Negretti and Zambra for the late Admiral FitzRoy. *See page* 19.

The Double Bulb Deep Sea Thermometer first constructed and supplied to Her Majesty's Navy by Negretti and Zambra in 1862. *For full particulars and the history of this important invention see pages* 147 *to* 149, 509 *to* 511.

The Standard Deep-Sea Thermometer the only Instrument capable of giving correct temperatures of the bottom or any intermediate depth of the sea, pages 512 *to* 514.

Negretti and Zambra's Patent Strengthened Glass Hydrometer. *See page* 169.

CONTENTS.

PREFACE.

In again presenting to our numerous friends and the general public a further enlarged and improved edition of our Encyclopædic Catalogue, we do so with a great degree of pardonable pride,—firstly, that all previous editions have been such as to command the extensive patronage bestowed upon them; and, secondly, from the award just made known at the "Great International Exhibition at Paris," that the superiority and excellence of our instruments, which gained for us the only Prize Medal in 1851, is still maintained, and manifested by the fact that in 1878 we have awarded to us the

ONLY GOLD MEDAL

given for our class of instruments in the British Section.

In this edition, as in all that have preceded it, our endeavour has been to make the work, not merely a list of prices, but in reality a guide for those who are purchasing Philosophical Instruments generally. All instruments are well described, some more fully than others, depending upon the importance of the apparatus or article under consideration.

Our Meteorological Instruments we particularly recommend to those who are about to commence making observations in the science of Meteorology as being the most improved and reliable that can possibly be produced. In confirmation of this we have only to state that for the past quarter of a century we have had the honour of supplying Standard Instruments to all the more important Meteorological Observatories, Scientific Institutions, and Governments of the world; most of the Geographical and Deep Sea Exploring Expeditions of the last twenty years have been supplied with our Instruments, or copies of Instruments invented by us, as was the case with some of the Thermometers supplied to the "Challenger" Expedition. See Correspondence in *Nature*, October 23rd, 1873. Copies of this Correspondence may be had at our Establishments.

To enumerate our various inventions and improvements would be, with some few additions, to repeat all that has been said in previous editions; as this to some, would be tedious, we specify these Inventions and Improvements on page 4, and indicate the section or page in the Catalogue where they will be found fully described. Our doing so must not be taken as an act of egotism (though we are proud of our work); but it is for the special purpose of placing

on record that we are the Inventors and Improvers of such instruments, as many of our inventions have been appropriated by manufacturers, and sold without the slightest acknowledgment of their origin.

Having branch establishments in London, viz., 45, Cornhill, E.C., 122, Regent Street, W. (communicating with the central establishment by special telegraph wire), and at the Crystal Palace, Sydenham, letters for these branches should be directed to them in full; but correspondence intended for the Central Establishment should be addressed, "Negretti and Zambra, Holborn Viaduct, London, E.C.," Foreign Correspondents may, if preferable to them, write in French, Italian, Spanish, or German.

At page 5 will be found a Table of Contents, referring to the pages where any particular section or class of apparatus will be found, and at page 327 an extensive general Index, giving the marginal number for each Instrument; these, combined with upwards of Twelve Hundred Wood Engravings (a large proportion of them New), will assist the reader in searching for any particular item.

Full and explicit instructions should accompany orders as to the Address, mode of Conveyance, or Shipment, Insurance, Consular Forms, and Declarations, etc., etc. Foreign or Country orders must be accompanied by a Remittance, Order for Payment, or Satisfactory Reference in London.

Every possible care being taken in packing Apparatus and Instruments to insure safety in carriage, *we cannot be responsible for any damage that may occur in transit after the goods leave our establishment.*

A liberal commission allowed to Merchants, Shippers, or Agents on large transactions. Merchants favouring us with copies of their clients' orders will have special quotations furnished to them. In many instances by our extensive knowledge and experience of Foreign Business, we are enabled greatly to assist in determining the particular instrument required by persons ordering from abroad, more especially where the order has been translated and copied by persons unacquainted with the nature or use of the Articles written for.

The compilation and revision of this New Edition of our Catalogue has again been entrusted by us to Mr. R. Willats, the manager of our retail department at Holborn Viaduct; and we hope that both as a Price List and a Book of Reference it will be found vastly superior to its predecessors.

NEGRETTI & ZAMBRA.

NEGRETTI AND ZAMBRA'S

DESCRIPTIVE CATALOGUE.

STANDARD

METEOROLOGICAL INSTRUMENTS.*

The practical usefulness of Meteorological Instruments as weather indicators, and their increased employment for Scientific and Sanitary purposes, render a knowledge of their construction and principles necessary and desirable to every well-informed person. Impressed with the idea that we shall be supplying an existing want, in giving simple descriptions of those now in use, we have endeavoured to condense such information regarding the instruments used in Meteorology in the present section of our Catalogue.

Every Meteorological Instrument of any practical value being fully described, with plain instructions for using them, purchasers will be enabled to select such as seem to them most suited to their requirements.

For convenience of reference and comparison we shall arrange and describe the different instruments used for Meteorological observation under the following headings, viz.: Instruments to show, 1st, the pressure of the atmosphere; 2nd, the temperature of the air; 3rd, the absorption and radiation of the sun's heat by the earth's surface; 4th, the humidity of the air; 5th, the amount and duration of rainfall; 6th, the direction, the horizontal pressure, and the velocity of winds; 7th, the electric condition of the atmosphere, the prevalence and activity of ozone, magnetic and tidal phenomena, &c., &c.

* The references in this Catalogue correspond with the Nos. of the Engravings.

INSTRUMENTS FOR ASCERTAINING THE ATMOSPHERIC PRESSURE.

BAROMETERS.

1. **Principle of the Barometer.**—The first instrument which gave the exact measure of the pressure of the atmosphere was invented by Torricelli, a Florentine pupil of Galileo, in 1643. It is constructed as follows: A glass tube, C D (fig. 1), about 34 inches long, and from two to four-tenths of an inch in diameter of bore, having one end closed, is filled with mercury. In a cup, B, a quantity of mercury is also poured. Then, placing a finger securely over the open end, C, invert the tube vertically over the cup, and remove the finger when the end of the tube dips into the mercury. The mercury in the tube then partly falls out, but a column, A B, about 30 inches in height, remains supported. This column is a weight of mercury, the pressure of which upon the surface of that in the cup is precisely equivalent to the corresponding pressure of the atmosphere. As the atmospheric pressure varies, the length of this mercurial column also changes. It is by no means constant in its height; in fact, it is very seldom stationary, but is constantly rising or falling in the tube. It is therefore, an instrument by which the fluctuations taking place in the pressure of the atmosphere, arising from changes in its weight and elasticity, can be shown and measured. It has obtained the name *Barometer*, or measurer of heaviness, —a word certainly not happily expressive of the utility of the invention. If the bore of the barometer tube be uniform throughout its length, and have its sectional area equal to a square inch, it is evident that the length of the column, which is supported by the pressure of the air, expresses the number of cubic inches of mercury which compose it. The weight of this mercury, therefore, represents the statical pressure of the atmosphere upon a square inch of surface.

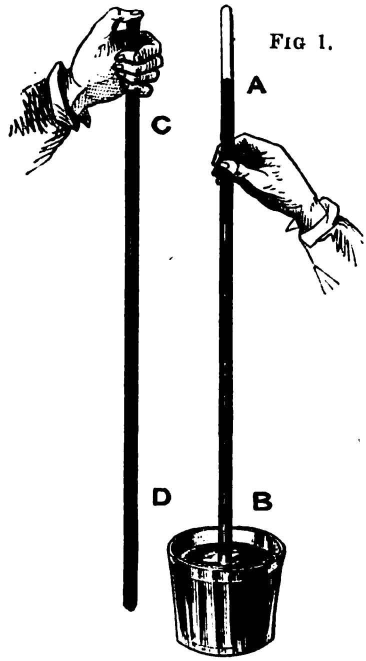


FIG 1.

In England the annual mean height of the barometric column, reduced to the sea-level, and to the temperature of 32° Fahrenheit, is about 29·95 inches. A cubic inch of mercury at this temperature has been ascertained to weigh 0·48967 lbs. avoirdupois. Hence $29{\cdot}95 \times 0{\cdot}48967 = 14{\cdot}67$ lbs., is the mean

value of the pressure of the atmosphere on each square inch of surface, near the sea-level, about the latitude of 50 degrees. Nearer the equator this mean pressure is somewhat greater; nearer the poles, somewhat less. For common practical calculations it is assumed to be 15 lbs. on the square inch. When it became apparent that the movements of the barometric column furnished indications of the probable coming changes in the weather, an attempt was made to deduce from recorded observations the barometric height corresponding to the most notable characteristics of weather. It was found that for fine dry weather the mercury in the barometer at the sea-level generally stood above 30 inches; changeable weather happened when it ranged from 30 to 29 inches, and when rainy or stormy weather occurred it was even lower. Thus, it became the practice to place upon barometer scales words (Fair, Change, Rain, &c.), indicatory of the weather likely to accompany, or follow, the movements of the mercury; and the instruments bearing them obtained the name "Weather Glasses."

2. **Fortin's Barometer.***—Fortin's plan of constructing a barometer cistern is shown in section by fig. 2. The cistern is formed of a glass cylinder, which allows of the level of the mercury within being seen. The bottom of the cylinder is made of flexible leather, like a bag, so as to allow of being pushed up or lowered by means of a screw, D B, worked from beneath. This screw moves through the bottom of a brass cylinder, C C, which is fixed outside, and protects the glass cylinder containing the mercury. At the top of the interior of the cistern is fixed a small piece of ivory, A, the point of which exactly coincides with the zero of the scale. This screw and moveable cistern-bottom serve also to render the barometer portable, by confining the mercury in the tube, and preventing its descending into the cistern.

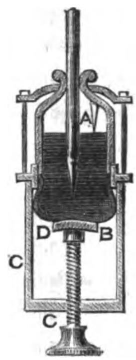


FIG. 2.

Fig. 3. exhibits the external construction of the cistern portion of a Standard Barometer. S S are metal screws that secure the glass cylinder or cistern G G partly filled with mercury, M, through this the tube T passes down into the flexible leather bag, with which the instrument is adjusted or made portable by the screw D B, as previously described. At P is shown the white ivory zero point to which the level of the mercury in the glass cistern is always corrected previous to reading off the height of the mercurial column. This Ivory point is seen at A in the section fig. 2, and at P in fig. 3.

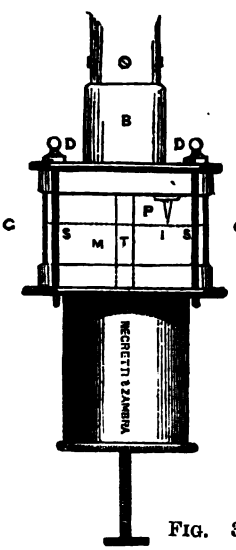


FIG. 3.

* This form of Barometer, now universally adopted by all makers, was originally introduced by Negretti and Zambra.

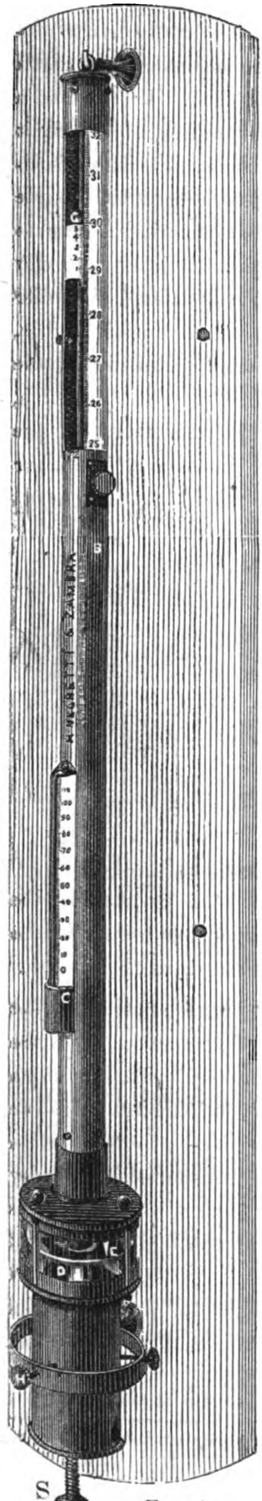


Fig. 4.

STANDARD BAROMETERS.

3. **Standard Barometer** (fig. 4), on Fortin's principle, reading from an ivory point in the cistern, to insure a constant level—with mercury boiled in the tube. The barometer tube, which is $\frac{4}{10}$ths of an inch diameter, is enclosed and protected by a tube of brass throughout its whole length; the upper portion of the brass tube has two longitudinal openings opposite each other; on one side of the front opening is the barometrical scale of English inches, divided to show, by means of a vernier, $\frac{1}{500}$th of an inch; on the opposite side is sometimes divided a scale of French millimetres, reading also by a vernier to $\frac{1}{10}$th of a millimetre; the reservoir or cistern of the barometer is of glass, closed at bottom by means of a leather bag, acted upon by a thumb-screw passing through the bottom of an arrangement of brass-work, by which it is protected, as shown in figs. 2 and 3. A delicate thermometer, with the scale divided on its stem, so arranged as to give, as accurately as possible, the temperatures of the column of mercury, is attached to the brass tube.

DIRECTIONS FOR FIXING STANDARD BAROMETERS.

In selecting a position for a barometer, care should be taken to place it so that the sun cannot shine upon it, and that it is not affected by direct heat from a fire. The cistern should be from two to three feet above the ground, which will give a height for observing convenient to most persons. A standard barometer should be compared with an observatory standard of acknowledged accuracy, to determine its index error; and should be capable of being turned on its axis, so as to obtain a good light for observation. Having determined upon the position in which to place the instrument, fix the mahogany board as nearly vertical as possible; and

ascertain if the barometer is perfect and free from air, in the following manner:—lower the screw at the bottom of the cistern several turns, so that the mercury in the tube, when held upright, may fall two or three inches from the top; then slightly incline the instrument from the vertical positon, and if the mercury in striking the top elicit a sharp tap, the instrument is perfect. If the tap be dull, or not heard at all, there is air above the mercury, this must be driven into the cistern by *inverting the instrument, and gently tapping it with the hand.* Presuming the barometer to be in perfect condition, it is next to be suspended on the brass bracket at the top of the mahogany board, the cistern passing through the ring at the bottom, and allowed to find its vertical position, after which it is firmly clamped by means of the three thumb-screws.

Directions for taking an Observation.—Having taken the temperature by the attached thermometer, the mercury in the cistern must be raised or lowered by means of the thumb-screw (S), fig 4, until the ivory point (E), and its reflected image in the mercury (D), are just in contact; the vernier is then moved by means of the milled head, until its lower edge just excludes the light from the *middle* and *uppermost* point of the mercurial column as seen in fig 5; the reading is then taken by means of the scale on the limb and the vernier. In observing, the eye should be placed in a right line with the fore and back edges of the lower termination or edge of the vernier. A small white reflector placed behind the barometer will assist in throwing the light through the brass frame and the glass tube; and the observer's vision may be further assisted by the use of a magnifying lens. The great object in standard baromters, is to obtain exact readings, which can only be done by having the eye, the front of the zero edge of the vernier, the top of the mercurial column, and the back of the vernier, in the same horizontal plane.

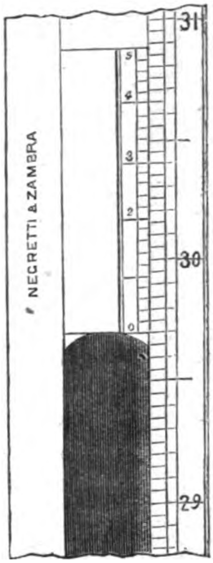


FIG. 5.

4. **The Barometer Vernier.**—The *vernier*, an invaluable contrivance for measuring small spaces, was invented by Peter Vernier, about the year 1630. The barometer scale is divided into inches and tenths. The vernier enables us to accurately subdivide the tenths into hundredths, and, even to thousandths of an inch. It consists of a short scale made to pass along the graduated fixed scale by a sliding or rack-and-pinion adjustment.

The scales of standard barometers are usually divided into half-tenths, or ·05, of an inch, as represented, in fig. 6*, by AB. The vernier, CD, is made equal in length to twenty-four of these divisions, and divided into twenty-five equal parts; consequently one space on the scale is larger than one on the

vernier by the twenty-fifth part of ·05, which is ·002 inch, so that such a vernier shows differences of ·002 inch. The vernier of the figure reading upwards, the lower edge, D, will denote the top of the mercurial column; and is the zero of the vernier scale. In fig 6, the zero being in line exactly with 29 inches and five tenths of the fixed scale, the barometer reading would be 29·500 inches. It will be seen that the vernier line, *a*, falls short of a division of the scale by, as we have explained, ·002 inch; *b*, by ·004; *c*, by ·006; *d*, by ·008; and the next line by one hundredth. If, then, the vernier be moved so as to make *a* coincide with *z*, on the scale, it will have moved through ·002 inch; and if 1 on the vernier be moved into line with *y* on the scale, the space measured will be ·010. Thus, the figures 1, 2, 3, 4, 5 on the vernier measure hundredths, and the intermediate lines even thousandths of an inch. In fig. 6*, the zero of the vernier is between 29·65 and 29·70 on the scale. Passing the eye up the vernier and scale, the second line above 3 is perceived to lie evenly with a line of the scale. This gives ·03 and ·004 to add to 29·65, so that the actual reading is 29·684 inches.

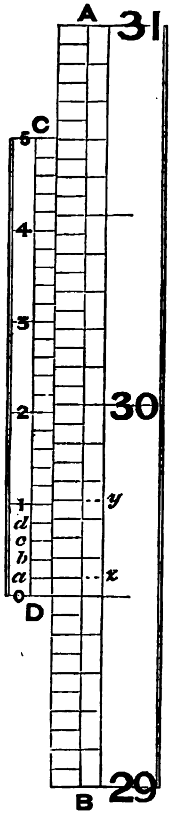


FIG. 6.

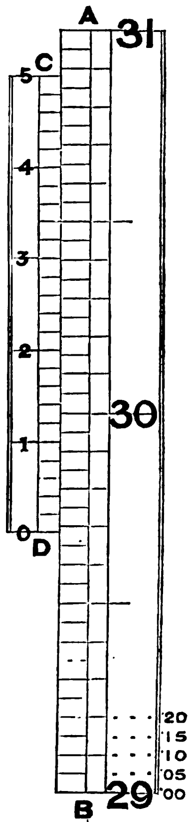


FIG. 6*.

For the ordinary purposes of the barometer as a "weather glass," such minute measurement is not required. In household and marine barometers, the scale is only divided to tenths, and the vernier constructed to measure hundredths of an inch. This is done by making the vernier either 9 or 11-10ths of an inch long, and dividing it into ten equal parts. The lines above the zero line are then numbered from 1 to 10; sometimes the alternate divisions only are numbered, the intermediate numbers being very readily inferred. Hence, if the first line of the vernier agrees with 1 on the scale, the next must be out one-tenth of a tenth, or ·01 of an inch from agreement with next *scale* line; the following vernier line must be ·02 out, and so on. Consequently, when the vernier is set to the mercurial column, the difference shown by the vernier from the tenth on the scale is the hundredths to be added to the inches and tenths of the scale.

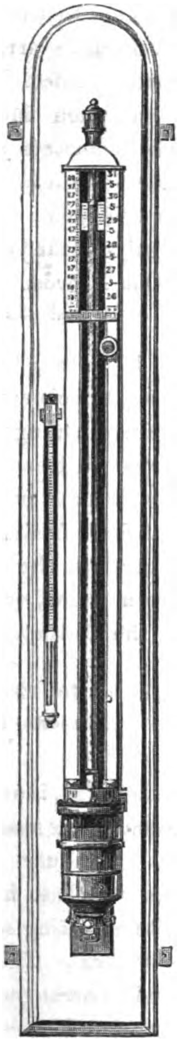


FIG. 8.

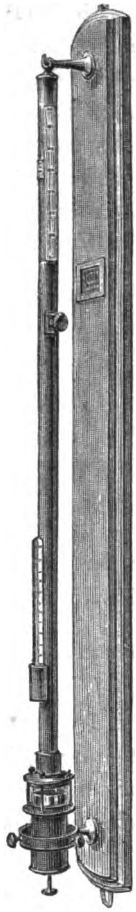


FIG. 7.

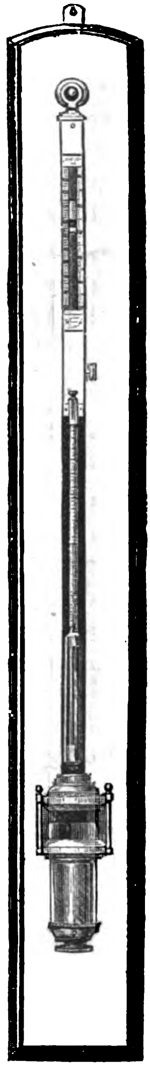


FIG. 9.

5. **Negretti and Zambra's Standard Barometer** with attached Thermometer, mounted on a Mahogany or Oak board as fig. 7. *Price,* £8 8 0

Ditto ditto with Millemetre Scale . . £9 9 0

6. **Negretti and Zambra's Standard Barometer** with attached Thermometer, having a tube of 0·45, of an inch internal diameter—with English and Millimetre scales, on Oak or Mahogany Board, fig. 4. *Price,* £10 10 0

7. **Standard Barometer.**—Mounted similiar to above with a tube $\frac{6}{10}$ths of an inch internal diameter. *Price,* £15 15 0 and £22 0 0

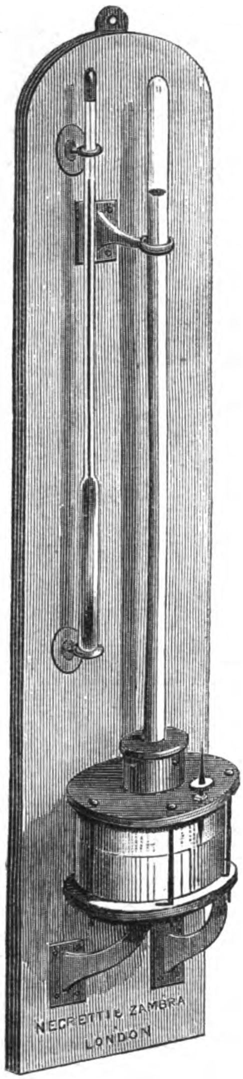


FIG. 10.

8. **Standard Barometers of extra large size** suited for Observatories or Public Institutions. Negretti and Zambra's improved Fortin's arrangement with English and Millimetre scales. The Barometer Tubes are $\frac{7}{10}$ths of an inch internal diameter and the bulbs of the Thermometers are of the same dimensions. The scales of these Thermometers are engine divided on the stem. These Barometers are mounted in highly-finished brass frames on polished Mahogany or Oak Boards.

Figs. 8 and 9, *Price*, £25 0 0 and £30 0 0

9. **Standard Barometer** fig. 10, with a tube of exceedingly large internal diameter, the cistern also being of very large area—especially arranged for taking observations with the most extreme precision. Our woodcut shews the Barometer to be *without* any scale, the readings being obtained by observing the level of the mercury in the tube, and the upper point of the cistern index, or zero screw through the telescope of the Cathetometer, described in the next paragraph.

Price, as fig. 10, £20 0 0

Or mounted in a massive Cast Iron Revolving Pedestal Frame, as used at Kew, £30 0 0

10. **The Cathetometer**, shewn in fig. 11, is used for ascertaining with the utmost accuracy the space or distance between any two points. A square brass rod or cylinder is firmly supported on a base having three arms, each arm furnished with adjusting screws for setting the upright rod truly vertical. This rod has a metal scale finely divided and so arranged that it revolves smoothly and freely round upon the upright horizontally.

Exactly at right angles to this scale and attached to it is a framework carrying a small Achromatic Telescope furnished with fine wire or spider lines in the eye-piece. This telescope is mounted with levels, having coarse and fine adjustments with clamps, &c., much in the same manner as a Theodolite Telescope. The distances between the points to be ascertained are observed through the Telescope, which can be moved with its adjustments vertically up and down upon the divided scale—this movement being read off upon the scale by verniers sub-dividing the scale to the five-hundredth or one thousandth of an inch.

The scale is divided either in English inches or Centimetres and Millimetres as may be desired.

Price of Cathetometer, simple form, £16 16 0 and £23 0 0

Cathetometer of large size, fully divided, with the most complete adjustments, as fig. 11, or mounted in accordance with the Kew Pattern. *Price*, £30 0 0

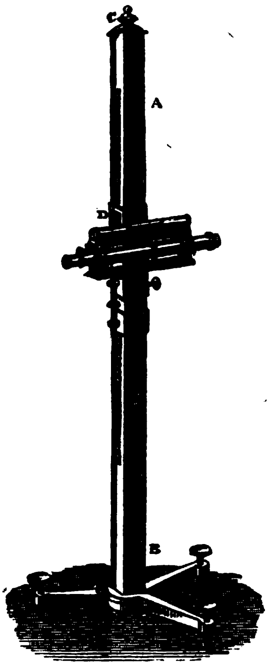


FIG. 11.

11. **Glass Cases for Standard Barometers** of polished ebonised wood with plate glass sides and door with secure fastenings for the exclusion of dust and preserving the instrument from injury.

Price £5 5 0 to £10 10 0

12. **Negretti and Zambra's Self-compensating Standard Barometer** consists of the usual form of standard instrument, but attached to the vernier is a double rack moved by one pinion, so that when adjusting the vernier in one position, the second rack moves in the opposite direction, carrying along with it a plunger (the exact size of the internal diameter of the tube) dipping in the cistern, so that whatever displacement has taken place in the cistern, owing to the rise or fall of the mercury, it is exactly compensated by the plunger being more or less immersed in the mercury, consequently no capacity correction is required. *Price*, £18 18 0

13. **Standard Barometer, with Electrical Adjustment.**—This barometer consists of an upright glass tube dipping into a glass cistern of mercury, so contrived, that an up-and-down movement, by means of a screw, can be imparted to it. Through the top of the tube a piece of platina wire is passed and hermetically sealed. The cistern also has a metallic connection, so that by means of copper wires (in the back of the frame) a galvanic circuit is established; another connection also exists by means of a metallic point dipping into the cistern. The circuit, however, can be cut off from this by means of a switch placed about midway up the frame. On one side of the tube is placed a scale of inches; with a small circular vernier, divided into 100 parts, connected with the dipping point, and working at right angles with this scale.

For taking an observation, a galvanic battery is connected by two binding screws at the bottom of the frame. The switch is turned upwards, thereby disconnecting the dipping point; the cistern is then screwed up, so that the mercury in the tube is brought into contact with the platina wire at the top; the instant this is effected a *magnetic needle* arranged as a galvanometer on the barometer board will be deflected. The switch is now turned down; by so doing the connection with the upper wire or platina is cut off, and established

FIG. 17.

FIG. 1.

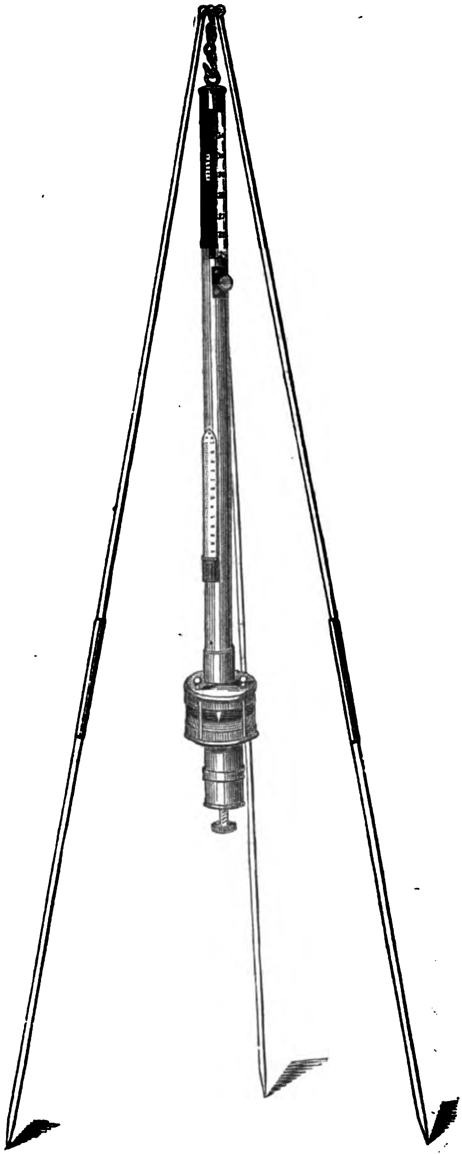


FIG. 13.

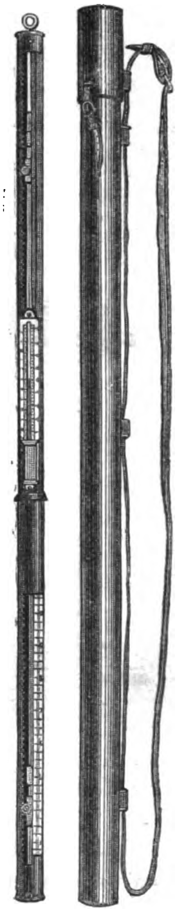


FIG. 16.

between the dipping point carrying the circular vernier and the bottom of the cistern; the point is now screwed by means of the milled head until the *needle* is again deflected, and the line on the vernier cutting the division on the scale is the exact reading of the barometer. *Price*, £18 18 0

14. **Mountain Barometer** (Newman's) in wooden frame, with brass shield and scale with vernier, thermometer, portable screw, &c. (fig. 12.) *Price* £4 10 0

This form of Barometer is now almost superseded by Nos. 15 and 18.

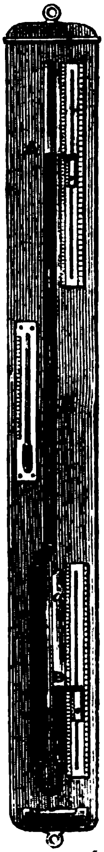


FIG. 14.

15. **Negretti and Zambra's Mountain Barometer** (fig. 13) on Fortin's principle, is more portable, and less liable to derangement than ordinary mountain barometers. The arrangement of the flexible leather cistern is so simple that should the mercury become oxidized, it can be quickly removed, cleaned, and returned to the cistern without fear of affecting the correctness of the indications. The vernier reads to ·002 of an inch, and the whole instrument is arranged in the most compact and convenient form for safety in travelling, and obtaining very accurate altitude measurements.

Price, including Brass Tripod Stand (as fig. 13) and Travelling Case for the Barometer, with English and Millimetre Scale £10 10 0

16. **Standard Mountain Barometer** of simpler form and smaller tube £8 8 0

17. **Standard Syphon Barometer** (Gay Lussac's), divided on the tube, suited for **laboratory use** (fig. 14), mounted on mahogany board, with thermometer and two verniers. £5 5 0

18. **Standard Syphon Tube Mountain Barometer** (Gay Lussac's), with attached thermometer, and improvement in the tube for excluding air. This is shown in fig. 15, and known as Gay Lussac's Air Trap; its use being to arrest any air that may pass up between the glass and the mercury. The bubbles of air are stopped and collected at the shoulder of the trap at K, and cannot possibly get up into the tube. This Barometer is light and convenient for travelling. The graduations are upon the brass tube with verniers at each extremity reading from the centre. By adding the two readings together the correct height of column is obtained to $\frac{1}{500}$th of an inch.

Price of Barometer, in leather travelling case, with Brass Tripod Stand (fig. 16) £8 8 0

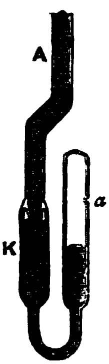


FIG. 15.

This Syphon Barometer does not require correction for either capillarity or capacity, as each surface of the mercury is equally depressed by capillary attraction, and the quantity of mercury which falls from the long limb of the tube occupies the same length in the short one. The barometric height must however, be corrected for temperature, as in the cistern barometer.

19. **Board of Trade Standard or Kew Marine Barometer,** mounted in a bronzed metal frame, with an iron cistern, and all the most recent improvements to prevent the mercury pumping in bad weather, as recommended by the Brussels Conference for Marine Meteorological Observations (fig. 17.)

Price, packed in case with lock and key £4 4 0

20. **Negretti and Zambra's Short Tube Barometer,** as specially constructed by N. and Z. for Mr. Glaisher's balloon experiments, or for altitude measurements at elevated mountain stations. *Price*, £7 7 0

21. **Magnifying the Barometer Range.**—The limit within which the barometric column oscillates, does not exceed four inches for extreme range, while the ordinary range is confined to about two inches; and it has often been felt that the utility of the instrument would be much enhanced if by any means the scale indications could be increased in length. This object has been sought to be obtained by bending the upper part of the tube from the vertical, so that the inches on the scale could be increased in length. Such an instrument was invented by Sir S. Moreland, in 1772, and named by him "the Diagonal Barometer." Another variation of Barometer, invented by M. Cassini, and improved by M. J. Benoulli, about the same date, was constructed with the upper part of the tube expanded into a large Bulb, and the lower part of the tube giving the scale is very much contracted in the bore, and bent at a right angle. From this the instrument was termed the Horizontal Rectangular Barometer. The upper part of the Barometer tube has also been formed into a Spiral, with the scale placed along it, which is thus greatly enlarged.

These methods of enlarging Barometer indications are not so convenient as Dr. Hook's elegant arrangement employed in the ordinary Dial or Wheel Barometer. Therefore they are now very little used, and are of very little practical utility.

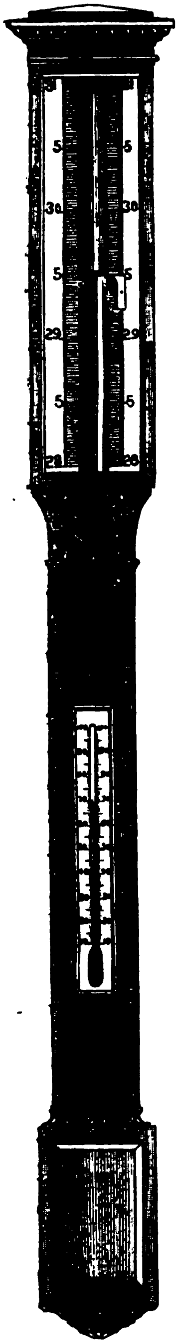
22. **Negretti and Zambra's Howson's Patent Long Range Barometer.**

"The object of this instrument is to add to the sensitiveness of the ordinary mercurial column, by giving it an increased range, a desideratum which it appears to accomplish with simplicity and efficiency.

"The principle of construction will be understood on reference to the diagram, fig. 18, which represents a section of the working parts of the barometer divested of its case.

FIG. 18.

"A is the barometer tube, which is of large dimensions, and of greater length than usual in proportion to the additional length of range which it is intended to apply to it. The cistern, B, is of a tubular shape, so as to contain a fixed depth of mercury, also determinable by the range. To the bottom of this cistern is attached, concentrically, a light stalk or long hollow tube, S, hermetically sealed, springing to a height of about 28 inches above the fixed level of the mercury in the cistern.



"When all the parts are *in situ*, as in the diagram, the tube A being freely suspended, and the whole filled with the requisite quantity of mercury, the immediate result of the arrangement is that the cistern hangs in suspension without the necessity of any fixed support. The stalk C, it will be observed, passes axially up the tube A, and terminates a little below the upper level of the mercury M: its upper end is therefore exposed to no more downward pressure than that caused by the weight of the mercury above it, and consequently there is an excess of upward pressure from the atmosphere exteriorly which tends to raise the cistern.

"If we suppose, for instance, the area of the stalk to be half a square inch, and its top to be covered with 1 inch in depth of mercury (the space above being of course a vacuum), there will be a pressure tending to push the cistern downwards of only $\frac{1}{4}$ lb. or thereabouts, while the atmosphere will be pressing upwards on an equal area with a force of 7 lbs. or more. Thus it will be seen that when the excess of upward pressure is exactly balanced by the weight of the cistern with its stalk, and contained mercury up to the level *b*, an equilibrium will be established which will keep the cistern stationary. If from any cause the cistern should become lighter, it will ascend: if it should become heavier, it will descend, and the extent to which it will move in either case will be limited by the immersion or emersion of the tube A, or rather of the glass which bounds it. This is precisely the action which takes place under the influence of the fluctuations of atmospheric pressure. For, let the internal area of the tube A be supposed to be 1 square inch, and let a barometric rise take place equal to 1 inch by the ordinary standard, it is evident that a cubic inch of mercury will under these conditions leave the cistern, pass into the tube, and accumulate above the top of the stalk: consequently the cistern, being relieved of a portion of its weight, will be pushed upwards until the cubic inch is replaced by the immersion of the glass of the tube A. As soon as this point has been reached it will become stationary; but in the mean time, in the act of rising, it will have pushed up the entire column before it; so that the total rise of the top of the column will be compounded of two motions, viz., of the ordinary barometric rise, and the rise of the cistern. The converse of this of course takes place on the occurrence of a fall of

FIG. 19.

atmospheric pressure. When the column moves, the cistern follows it in all cases, and when the cistern moves, it drags the entire column with it.

"The instrument has been in use for many years, and its movements have been found to follow with accuracy those of the best standard Barometers. Its sensitiveness and activity during storms is especially conspicuous. There is also an incidental advantage which the construction confers, viz., that the cistern is self-adjusting with regard to its level. Readings may be taken to three places of decimals without a vernier, and without any adjustment for variation of level in the cistern. At the same time, the error due to temperature is of an almost inappreciable amount." *

Price, in Ornamental carved Oak Case as fig. 19, £12 12 0

23. **McNield's Long Range Barometer.**—A barometer designed on a directly opposite principle to the one just described. The tube is made to float on the mercury in the cistern. It is filled with mercury, inverted in the usual manner, then allowed to float, being held vertically by glass points or guides. By this contrivance, the ordinary range of the barometer is greatly increased. As the mercury falls in the tube with a decrease of pressure, the surface of the mercury in the cistern rises, and the floating tube rises also, which causes an additional descent in the column, as shown by graduations on the tube. With an increase of pressure, mercury will leave the cistern and rise in the tube, while the tube itself will fall, and so cause an additional ascent of mercury.

Price, £12 12 0

Both Howson's and McNield's Barometers are constructed by Negretti and Zambra with scales of from five to eight times that of the ordinary standard. Their sensitiveness is consequently increased in an equal proportion, and they have the additional advantage of not being affected by differences of level in the cistern.

THE ANEROID BAROMETER.

24. Before describing the modern Aneroid Barometer, we think it may prove interesting to our readers to give in a few words particulars of the first attempt to produce a portable metallic Pocket Barometer.

"M. Conté, in his balloon ascents during the war in Egypt, found the ordinary mercurial barometer subject to so much oscillation that it was useless. He was the inventor of the Vacuum-Vase, and subjoined is an engraving of his instrument, and the description he gives of it, extracted from the 'Bulletin des Sciences, Floreal, An. 6,' page 106.

"M. Conté, Professor of the Aerostatical School at Meudon, near Paris, and now in Egypt, has occupied his attention for some time past in adapting a barometer, which, although of a simple contrivance, should be more sensitive than those

* *Extract from the Proceedings of the British Meteorological Society, Nov. 20th,* 1861. Vol. i. p. 81.

already in use. We now proceed to explain the first of his discoveries. It is shown in fig. 20, and is very like a pocket watch. A B C is a bowl made of strong iron or copper, upon which is a cover, C F A, of a very thin sheet steel, and the edges of which must be fitted with great exactness. The springs R R keep the cover at its elevation; and while they regulate its action, the air is pumped out of the bowl A F C B, through the opening at D. This opening shuts itself so as to be air-tight, and then the whole weight of the atmosphere forces down the flexible bowl C F A. Now, as the resistance of the springs remains constantly the same, this cover-plate rises or falls as the atmospheric pressure varies; and these variations are shown by means of a hand, securely fastened, which passes backwards or forwards upon a divided plate." The discoverer, however, acknowledges that he was compelled to reject this instrument, on account of the prejudicial influence which the change of temperature had upon it.

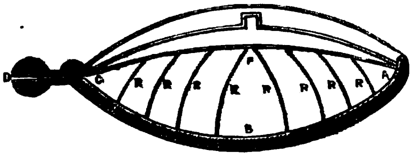


FIG. 20.

"From the above diagram, there may be adduced many strong reasons, besides that which M. Conté has stated, to show why he was not successful. The principal one would really suggest itself to any person of mechanical information. The figure he chose as the object of atmospheric compression is, perhaps, of all forms, the worst adapted for that purpose—viz., an *arch*. That he has recorded the principle cannot be disputed; but when we consider what has been stated relative to the form of his Vacuum-Vase, to say nothing of its inadequately small dimensions, we must be permitted to question if he ever obtained any practical result. The extreme ingenuity of M. Vidi, the inventor of the instrument about to be described, appears, then, to be in no way disparaged by the claims to the invention of the principle, which have been set up for M. Conté by his friends."

25. **The Aneroid Barometer.** The extremely ingenious instrument called the *Aneroid*, is no less remarkable for the scientific principles of its construction and action, than for the nicety of its mechanism. As its name implies, it is constructed "without fluid." It was invented by M. Vidi of Paris. In the general form in which it is made it consists of a brass cylindrical case about four inches in diameter and one and a half inch deep, faced with a dial graduated and marked similarly to the dial-plate of a "wheel-barometer," upon which the index or pointer shows the atmospheric pressure in inches and decimals in accordance with the mercurial barometer. Within the case, is placed a flat metal box made of German Silver, generally not more than half an inch deep and about two inches or a little more in diameter, from which nearly all the air is exhausted. The top and bottom of this box is corrugated in concentric circles, so as to yield inwardly to external pressure, and return

when it is removed. The pressure of the atmosphere continually changes, and with this varying pressure, the top and bottom of the box approach to and recede from each other by a small quantity; but the bottom being fixed to the base, nearly all this motion takes place on the top. The top of the box is elastic, and rises and falls according as the compressing force lessens or increases. To the eye these expansions and contractions are not perceptible, so small is the motion. But they are rendered very evident by a delicate mechanical arrangement, communicating with a system of levers; and, by the intervention of a piece of watch-chain and a fine spring passing round the arbour, turning the index to the right or left, according as the external pressure increases or decreases. Thus, when by increase of pressure the vacuum box is compressed, the mechanism transfers the movement to the index, and it moves to the right; when the vacuum box expands under diminished pressure, the motion is reversed, and the index moves to the left. As the index traverses the dial, it shows upon the scale the pressure corresponding with a good mercurial barometer.

The Aneroid being placed under the receiver of an air pump the scale is laid off to correspond with a Mercurial Barometer Gauge, and afterwards compared and corrected by a standard instrument.

The engraving (fig. 21) represents the latest improved mechanism of an aneroid. The outer casing and face of the instrument are removed, but the index hand is left attached to the arbour. *A* is the corrugated vacuum box which has been exhausted of air through the tube *J*, and hermetically sealed by soldering. *B* is a powerful curved spring, resting in gudgeons fixed on the base-plate, and attached to a socket behind, *F*, in the top of the vacuum box. A lever, *C*, joined to the stout edge of the spring, is connected, by the bent lever at *D*, with the chain, *E*, the other end of which is coiled round, and fastened to the arbour, *F*. As the box, *A*, is compressed by the weight of the atmosphere increasing, the spring, *B*, is tightened, the lever, *C*, depressed, and the chain, *E*, uncoiled from *F*, which is thereby turned so that the hand, *H*, moves to the right. In the meanwhile the spiral spring, *G*, coiled round *F*, and fixed at one extremity to the frame-work, and by the other to *F*, is compressed. When, therefore, the pressure decreases, *A* and *B* relax, by virtue of their elasticity; *E* slackens, *G* unwinds, turning *F*, which carries the index hand, *H*, to the left. Near *J* is shown an iron pillar, cast as part of the stock of the spring, *B*. A screw works in this pillar through the bottom of the plate, by means of which the spring, *B*, may be so adjusted

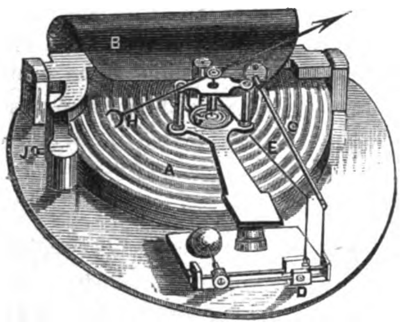


FIG. 21.

to the box, A, as to set the index, H, to read on the scale in accordance with the indications of a Mercurial Barometer. In the higher class of aneroid barometers, the lever, C, is formed of a compound bar of brass and steel, so skilfully arranged as to perfectly compensate for the effects of extreme variations of temperature.

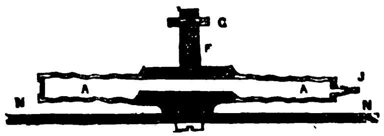


FIG. 18.

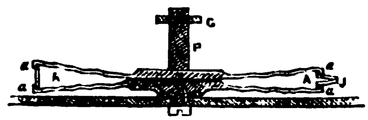


FIG. 19.

Figs. 18, 19 are sectional diagrams of the corrugated Vacuum-Box of the Aneroid, the various letters being in accordance with fig. 17. Fig. 18 shows the Vacuum chamber before exhaustion by the air pump and opposite to it is fig. 19 showing the condition of the Vacuum chamber after it has been exhausted as perfectly as possible. When the upper surface is attached to the spring B, at C it is held in a state of tension midway between the two positions shewn in the diagrams, and the varying pressure of the atmosphere depresses or allows this diaphragm to rise, and by the mechanism described above to indicate the varying atmospheric pressure.

Compensation for temperature in some of the earlier made Aneroid Barometers is said to have been obtained by charging the Vacuum chamber with *a Gas*—by some stated to have been Hydrogen, and by others Carbonic Acid Gas. The scientific reason for the use of either one or the other is not very apparent, and we doubt if either was really ever employed except for experiment. The greatest perfection in Aneroids is now attained by having as perfect and dry a Vacuum as possible. Compensation being obtained by a compound metal rod or bar as previously mentioned.

A Thermometer is sometimes attached to the Aneroid, as it is convenient for indicating the present temperature of the air, but for accuracy and safety from breakage, N. and Z. recommend the use of a separate Thermometer.

Admiral FitzRoy, in his *Barometer Manual*, writes: "The Aneroid is quick in showing the variation of atmospheric pressure; and to the navigator who knows the difficulty, at times, of using barometers, this instrument is a great boon, for it can be placed anywhere, quite out of harm's way, and is not affected by the ship's motion, although faithfully giving indication of increased or diminished pressure of air. In ascending or descending elevations, the hand of the Aneroid may be seen to move (like the hand of a watch), showing the height above the level of the sea, or the difference of level between places of comparison."

"Aneroid barometers, if occasionally compared with a mercurial standard, are similar in their indications, and valuable; but it must be remembered that

for exact scientific observation, the Aneroid barometer cannot be put into comparison with the mercurial column for strict accuracy, although its convenient size and great sensibility render it most useful for obtaining observations where a mercurial instrument is inconvenient to carry.

Col. Sir H. James, R.E., in his *Instructions for taking Meteorological Observations*, says of the Aneroid: "This is a most valuable instrument, it is extremely portable. I have had one in use for upwards of ten years."

One of the objects of Mr. Glaisher's experiments in balloons was "to compare the readings of an Aneroid barometer with those of a mercurial barometer." In the comparisons the readings of the mercurial barometer were corrected for index-error and temperature. Speaking of Aneroid indications,* Mr. Glaisher remarks:—

"A third (Aneroid) graduated down to five inches, and most carefully made and tested under the air-pump before use, read the same as the Mercurial Barometer throughout the high ascent to seven miles, September 5th, 1862.† I have taken this instrument up with me in every subsequent high ascent, and it has always read the same as the Mercurial Barometer. These experiments prove that an Aneroid can be made to read correctly at low pressures.

FIG. 20.

"I may mention that on several occasions, Aneroid Barometers have been taken whose graduations have been too limited for the heights reached: these have not broken or become deranged by being subjected to a much less pressure than they were prepared for, but have resumed their readings on the pressure again coming within their graduations." The Aneroids used by Mr. Glaisher were made for him by Messrs. Negretti and Zambra.

* Travels in the Air. By F. Glaisher. Page 89. The Aneroid Barometer.

† Wolverhampton to Cold Weston, near Ludlow, 5th September, 1862.

FIG. 21.

FIG. 22.

Directions for using the Aneroid.—Aneroids are generally suspended with the dial vertical; but if they be placed with the dial horizontal, the indications differ a few hundredths of an inch in the two positions. Therefore, *if their indications are to be recorded, the instrument should be read off always in the same position.*

As before observed, the Aneroid will not answer for exact scientific purposes, as its error of indication changes slowly, and hence the necessity of its being set from time to time with the reading of a Standard Barometer. To allow of this being done, at the base of the outer case is a screw in connection with the spring attached to the vacuum box. By applying a small screw-driver to this screw, the spring of the vacuum box may be tightened or relaxed, and the index hand adjusted to the right or left on the dial, as in correcting a watch.

26. **Pocket Aneroid Barometers.**—The patent for the aneroid having expired, Admiral FitzRoy urged upon Messrs. Negretti and Zambra the desirability of reducing the size of the instrument as then made, as well as of improving its mechanical arrangement, and compensation for temperature. They accordingly engaged skilful workmen, who, under their directions, and at their expense, by a great amount of labour and experiment, succeeded in reducing its dimensions to two inches in diameter, and an inch and a quarter thick. The exact size and appearance of these Aneroids is shown by fig. 20.

27. **Watch Aneroid.**—Negretti and Zambra have still further reduced the size of the Aneroid to that of an ordinary watch, our engravings, figs. 21, 22 shewing their exact size. By a beautifully simple contrivance, a milled rim is

constructed to move round, and carry with it the index or pointer over the scale engraved on the dial, for the purpose of marking the reading, so that any increase or decrease of pressure may be readily seen. These very small instruments are found to act quite as correctly as the largest, and are much more convenient. Besides serving the purpose of a weather-glass in the house or away from home, if carried in the pocket, they are admirably suited to the exigencies of tourists and travellers. They may be had with scale sufficient to measure heights of 20,000 feet; with a scale of elevation in feet, as well as of pressure in inches, engraved on the dial. The scale of elevation, which is for the temperature of 50°, was computed by Professor Airy, the Astronomer Royal, who kindly presented it to Messrs. Negretti and Zambra, for publication.* Moderate-sized Aneroids, fitted in leather sling cases, are found very serviceable to pilots, fishermen, and for use in coasting and small vessels, where a mercurial barometer cannot be employed, because requiring too much space.

Admiral FitzRoy, writing on this subject to the *Mercantile Marine Magazine*, December, 1860, says:—"Aneroids are now made more portable,† so that a pilot or chief boatman may carry one in his pocket, as a railway guard carries his time-keeper; and, thus provided, pilots cruising for expected ships would be able to caution strangers arriving, if bad weather were impending, or give warning to coasters or fishing boats."

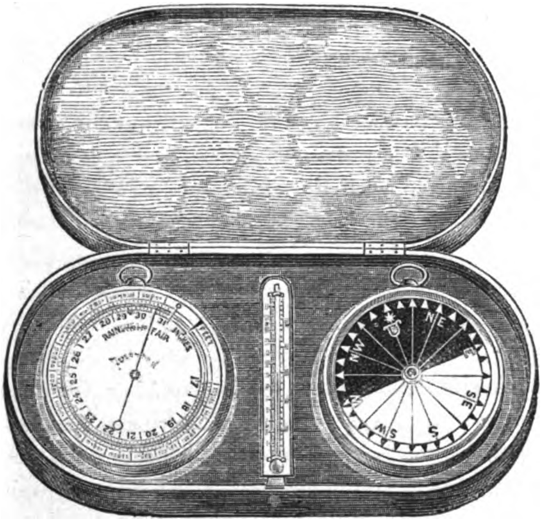


FIG. 23.

Negretti and Zambra's Watch-sized Aneroid Barometers, figs. 21 and 22, have now for many years been fully tried and tested, as ordinary Weather Indicators, for obtaining altitude measurements, and also for mining purposes. From the very extensive patronage afforded to them by Government authorities

* See List of Books on Meteorology at end of this Section.

† The first Pocket Barometer ever produced was manufactured by *Negretti and Zambra, for Admiral FitzRoy.*

(for military and naval service), engineers, surveyors, and scientific observers, &c. N. and Z. therefore feel justified in giving their unqualified recommendation to these instruments, for travellers' use, as being both accurate and convenient.

Our woodcuts, figs. 20, 21, 22, show form and actual size of some of the most useful Aneroid Barometers. Fig. 20 being our Pocket size. Fig 21 our Watch size, with the simple Barometer Scale of inches and 20ths of an inch. This same size instrument is manufactured with Altitude Scales ranging from 10 to 20 thousand feet. Fig. 22 is of similar size to the preceding, but has the altitude scale arranged *to revolve*, so that the zero or 0 of this scale being set to the point occupied by the Index at the commencement of the ascent, the elevation attained above the starting point may be at once seen in a *rough way* on the scale. The divisions of this scale not being absolutely similar all round, causes an error in the reading, therefore, *where exact observations are desired*, the zero of the scale should be placed opposite to the 31 point, and the indications read off in the usual manner by inches and fractions, their value being known by reference to the Altitude Tables sent with the instrument, so that this form of Aneroid combines both methods of observing in one instrument.

Our fig. 23 shows one of the most convenient arrangements yet introduced of the Aneroid, with a reliable Thermometer and Compass. The hinged leather case containing the three instruments, being but little larger than an ordinary portemonnaie.

28. **Measurement of Heights by the Aneroid.**—The dial of the Watch Aneroid for determining altitudes is engraved with two scales in concentric circles, the inner circle being divided into inches and tenths of an inch, corresponding with the scale of the mercurial column of a Standard Barometer. The outer circle is divided into spaces representing 100 feet, each tenth division being numbered as 1,000, 2,000, &c. The zero point of this scale corresponds with 31 inches of the Barometer scale, for this reason, that the Barometer never rises so high as 31 inches, consequently, our scale of feet is always outside the weather range. The zero of the feet scale has nothing whatever to do with the sea-level, that is a variable point and must be determined at the time of observation either by actual measurement at half tide level, or by computation from a known height.

29. **Measurement of Altitudes above Sea Level.**—In order to determine the height of any station above the sea-level with this instrument, we must notice at what point it stands at the shore; we then ascend, and on reaching the desired point, observe the position of the index on the dial. We then deduct the number of feet opposite the reading on starting from that against the reading at the elevated station, this gives the height above the level of the sea. Thus, if at sea-level, the barometer stands at 30 inches, and at the elevation it stands at 26 inches we get 900 feet, deducted from 4,800 feet, giving us a height of 3,900 feet, and so on for the other points of the scale.

When great accuracy is required, simultaneous observations must be taken at the two stations to obviate any error that might arise from a change of weather between the times of observation.

Further instructions for altitude measurement will be found in Negretti and Zambra's Treatise on Meteorological Instruments.

Aneroid Barometers may be had with the French Millimetre scale, or with the English and corresponding French scale engraved on the same instrument.

"Great storms are invariably preceded by a fall in the barometer of from ·05 to ·10 of an inch per hour. Storms from the eastward sometimes give less *local* warning, but they are well foretold by the increase of *statical force.* Storms of a cyclonic character travel, it has been found, on an average about 20 miles an hour towards some point between NE. and SE., generally towards the former. They, therefore, take about twenty-four hours to traverse the British Isles, from the time of their commencement in the west of Ireland. The east coasts may thus be warned one day in advance by the telegraph; and as the approach of a storm can be foreseen at the place threatened hours before its advent, notice of gales may usually be given from one to two days in advance. As regards the exact time and locality, the prognostication of storms must necessarily present much difficulty. The forecaster must be guided in these respects rather by experience, to be gained by practice, than by principles; little information can be given without going into a complete examination of particular storms, each of which would present points of difference."

Strachan's Weather Forecasts.

COMPARISON
OF THE
ENGLISH AND METRICAL SCALES OF BAROMETERS
AT ALL
TEMPERATURES *COMMON TO BOTH.*
BY F. F. TUCKETT, Esq.

Inches.		Millimétres.	Inches.		Millimétres.
32	—	812·5312	16	—	406·2656
31	—	787·1396	15	—	380·8740
30	—	761·7480	14	—	355·4824
29	—	736·3564	13	—	330·0908
28	—	710·9648	12	—	304·6992
27	—	685·5732	11	—	279·3076
26	—	660·1816	10	—	253·9160
25	—	634·7900	9	—	228·5244
24	—	609·3984	8	—	203·1328
23	—	584·0068	7	—	177·7412
22	—	558·6152	6	—	152·3496
21	—	533·2236	5	—	126·9580
20	—	507·8320	4	—	101·5664
19	—	482·4404	3	—	76·1748
18	—	457·0488	2	—	50·7832
17	—	431·6572	1	—	25·3916

PRICE LIST OF ANEROID BAROMETERS.

	£	s.	d.
Aneroid Barometer, with Enamelled Card dial, about 5 inches diameter	2	10	0
Ditto ditto with Silvered Metal Dial	3	0	0
Ditto ditto ditto with Thermometer	3	10	0
Aneroid Barometers, with elegantly chased Silvered Dials, and Bevelled-edge Plate Glass Cover	4	4	0
Ditto ditto with raised Ring on Dial	5	5	0
Ditto ditto ditto with Thermometer	6	6	0
Negretti and Zambra's Compared and Corrected Scale Aneroid, Compensated for temperature, as supplied to the Royal Navy and Meteorological Department	5	5	0
Negretti and Zambra's Surveyors' or Engineers' Aneroid Barometer, for Altitude Measurements, Plate Glass Cover, with Revolving Ring, carrying Index, range of Scale 10,000 feet 4½ inches diameter	7	7	0
Negretti and Zambra's Full Range Engineers' Altitude and Surveying or Balloon Aneroid, corrected and compensated for temperature, with 20,000 feet, Altitude Scale reading to $\frac{1}{100}$ of an inch, with Magnifier attached to the Revolving Ring	8	8	0
See also Section—Surveying Instruments.			
Negretti and Zambra's Mining Surveyors' Aneroid Barometer, with a Scale reading to 7,000 feet above the Sea Level, to 2,000 feet below	5	10	0
Stout Leather Case with Sling Strap, for any of the above	0	12	6

POCKET ANEROID BAROMETERS.

	£	s.	d.
Negretti and Zambra's Pocket Aneroid Barometer, 2¾ inches diameter, with Silvered Metal Scale fig. 20 . . . £3 3 0 and	3	10	0
Ditto ditto with Revolving Ring carrying Index	4	4	0
Mountain Aneroid Barometer, for measuring Altitudes to 10,000 feet, Compensated for temperature, in Leather Case	5	5	0
Ditto ditto ditto to 20,000 feet, with Magnifier attached to Revolving Ring	6	6	0

WATCH-SIZE ANEROID BAROMETERS

In Gilt Metal Cases (see figs. 21 and 22.)

	£	s.	d.
Negretti and Zambra's Watch-Sized Aneroid Barometer, weather range	3	3	0
Ditto ditto fully divided for Altitudes to 7,000 feet	4	4	0
Ditto ditto of best Construction, extra thin, for Meteorological Observations or Altitude Measurements to 10,000 feet	5	5	0
Negretti and Zambra's Watch-Sized Aneroid Barometer to 20,000 feet, Compensated for temperature	6	6	0
Negretti and Zambra's Watch-Sized Aneroid Barometer, with *Revolving* Altitude Scale for 10,000 or 20,000 feet . . . £6 6 0	6	10	0

Either of the above Watch-sized Barometers may be had in Stout Silver Cases, similar to a Hunting Watch, at a cost of £2 2s. extra.

	£	s.	d.
Pocket Aneroids in Round Hinged Case of several different Patterns and Combinations of Thermometers and Compass . £6 6 0 £7 7 0	8	8	0
Watch-Sized Aneroid Barometers with Thermometer and Compass, in flat hinged case, as fig. 23 . . . £6 10 0 and	7	7	0

Watch-sized Aneroid Barometers in highly finished, Solid Gold Cases. £15 15s. to £21.

SELF-REGISTERING BAROMETERS.

For many years a good and accurate self-recording barometer was much desired. This want is now satisfactorily supplied, not by one, but by several descriptions of apparatus. The first was the design of Admiral Sir A. Milne, who himself constructed, in 1857, we believe, the original instrument, which he used with much success.

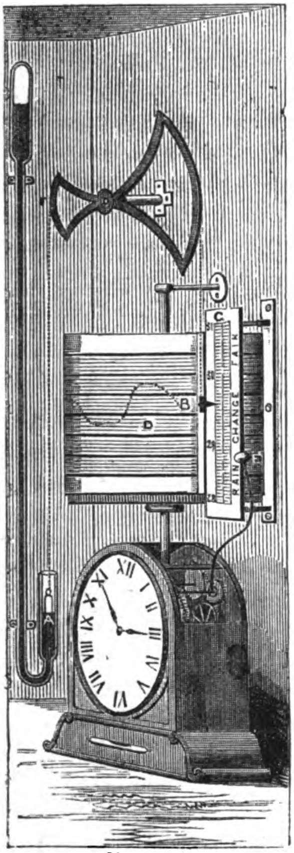


FIG. 24.

29*. Negretti and Zambra's improved Self-Registering Mercurial Barometer or Barograph. In this instrument the various parts of the mechanism have been so modified and arranged that the record on the papers is obtained with the greatest precision and delicacy. The engraving (fig. 24) will give the general details. It should, however, be mentioned, that it *is not a picture of the outward appearance of the instrument.* The position of the barometer should be behind the clock; it is represented on one side merely for the purpose of clearly illustrating the arrangement. The instrument has a large syphon barometer tube, in which the mercurial column is represented. On the mercury at *A*, floats a glass weight, attached to a silk cord, the other end of which is connected to the top of the arched head on the short arm of a lever-beam. The long arm of this beam is twice the length of the short arm, for the following reason. As the mercury falls in the long limb, it rises through an equal space in the short limb of the tube, and *vice versa.* But the barometric column is the difference of height of the mercury in the two limbs; hence the rise or fall of the float through half-an-inch will correspond to a decrease or an increase of the barometric column of one inch. In order, then, to record truly the movements of the mercurial column, and not those of the float, the arm of the beam connected with the float is only half the radius of the other arm. From the top of the large arched head a piece of watch-chain descends, and is attached to the marker, *B*, which properly counterpoises the float, *A*, and is capable of easy movement along a groove in a brass bar, so as to indicate the barometric height on an ivory scale, *C*, fixed on the same vertical framing. On the opposite side of the marker, *B*, is a metallic point, which faces the registration sheet and is nearly in contact with it. The framing, which carries the scale and marker, is an

arrangement of brass bars, delicately adjusted and controlled by springs, so as to permit of a quick horizontal motion, being communicated to it by the action of the hammer, *E*, of the clock, whereby the point of the marker is caused to impress a dot upon the paper. The same clock gives rotation to the cylinder, *D*, upon which is mounted the registering paper. The clock must be re-wound when a fresh paper is attached to the cylinder, which may be daily, weekly, or monthly, according to construction; and the series of dots impressed upon the paper shows the height of the barometric column every hour by day and night. The space traversed by the marker is precisely equal to the range of the barometric column.

Price, in an Ornamental Oak Case . £18 18 0 and 22 0 0

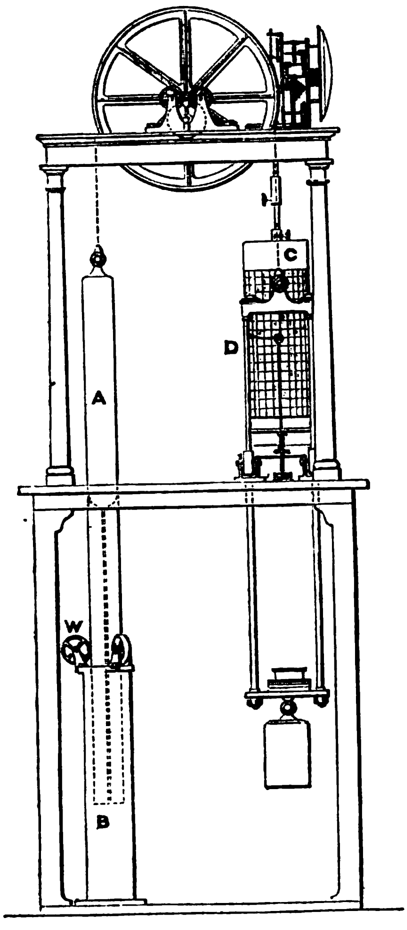


FIG. 25.

30. **King's Self-Registering Barometer.** Mr. Alfred King, Engineer of the Liverpool Gas-Light Company, designed, in 1854, a barometer to register, by a continuous pencil-tracing, the variations in the weight of the atmosphere; and a highly-satisfactory instrument, on his principle, and constructed under his immediate superintendence, has recently been erected at the Liverpool Observatory.

Fig. 25 is the front elevation of this Barometer. *A*, the barometer tube, is three inches internal diameter, and it floats freely (not being fixed as usual) in the fixed cistern, *B*, guided by friction-wheels, *W*. The top end of the tube is fastened to a chain, which passes over a grooved wheel, turning on friction rollers. The other end of the chain supports the frame, *D*, which carries the tracing pencil. The frame is suitably weighted and guided, and faces the cylinder, *C*, around which the tracing paper is wrapped, and which rotates once in twenty-four hours by a clock movement. For one inch change in the mercurial column the pencil is moved through five inches, so that the horizontal lines on the tracing, which are half an inch apart, represent one-tenth of an inch change in the barometer. The vertical lines are hour lines, and being nearly three-quarters of an inch apart, it will be seen that the smallest appreciable change in the barometer, and the time of its occurrence, are recorded. The barometer in this instrument is similar to Mr. McNeild's "Long-Range Barometer," described page 14.

Constructed to order £280 to £300

NEGRETTI AND ZAMBRA'S
SELF-RECORDING ANEROID BAROMETER.

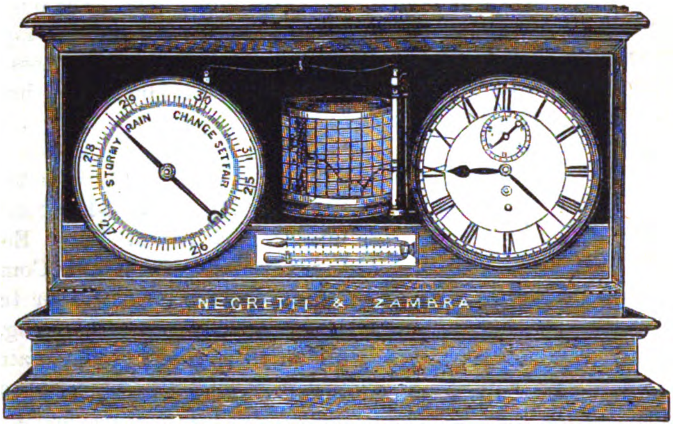


FIG. 26.

31. This Instrument is arranged to show the various fluctuations that have taken place in the barometer during the absence of the observer. It consists of a large and carefully finished Aneroid, and an eight-day Clock; between these is placed in a vertical position, a revolving cylinder having a metallic paper attached to it ruled to coincide with the inches and tenths of the barometer scale. Close to this paper, is a pencil mounted on a metallic rod and is moved up and down as the variation of atmospheric pressure acts upon the vacuum chamber of the Aneroid; at every hour this pencil is made to mark the paper by simple mechanism in connection with the Clock.

By this means a black dotted curved line is produced on the paper, showing at a glance the present height of the barometer—whether it is falling or rising—for how long it has been doing so, and at what rate the change has taken place—if falling or rising at the rate of one-tenth of an inch per hour, or one-tenth in twenty-four hours; all of which are particulars most essential to know when foretelling the weather, and which can only be obtained from an ordinary barometer by very frequent and regular observations.

Our engraving (fig. 26.) shews the ordinary mounting of the Registering Aneroid, combining a reliable time-piece with an exceedingly interesting meteorological instrument, of a suitable and convenient size for a library or dining room mantel-shelf. *Price,* £22 0 0

More ornamental mountings can be designed to correspond with any style of architecture or furniture to order. Some engravings of these will be found in our Section on "Dial Barometers."

INSTRUMENTS FOR ASCERTAINING THE TEMPERATURE OF THE AIR.

THERMOMETERS.

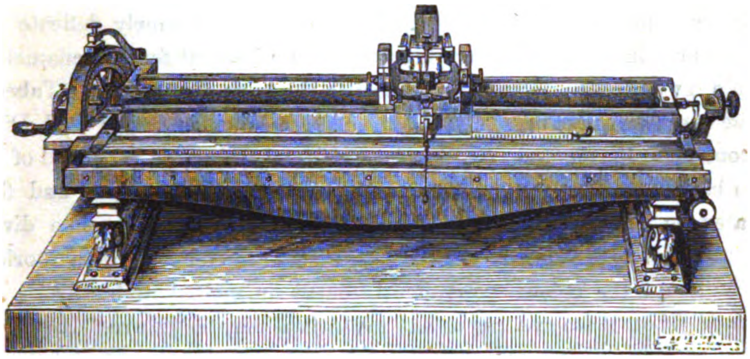


FIG. 27*.

32. Undoubtedly there is no instrument the use of which has so greatly increased in the past few years as the Thermometer: not only is it now essential to the Scientific observer, the Meteorologist, the Physician, and the Chemist; but both for domestic uses and manufacturing processes a really accurate thermometer is indispensable. The following is a list of the various forms of Standard Thermometers manufactured by Negretti and Zambra, all of these, to ensure extreme accuracy, have their scales divided by the Prize Dividing Engine (fig. 27*) to which was awarded a Prize Medal at the Great Exhibition of 1851, and is described in theReport of the Jurors as follows:—

"This is a beautifully contrived Divider on Ramsden's prinçiple, with a long fine steel screw. The novelties are—first, the wheel at the screw head, which is divided into 400 parts, and has cut upon its circumference (which is made broad) a helix screw, in the thread of which runs a detent, carried along by the run of the thread till it meets a stop clamped on the helix at a definite point. This arrests the screw at this point of the motion. A Prize Medal was awarded."

Messrs. Negretti and Zambra supply Dividing Engines made on the above principle both for Circular and Straight Line divisions.

Price . £35 to £150

NOTE.—From Report of the Juries of the Exhibition of 1851. "Negretti and Zambra are the only exhibitors in the British portion who have sent *Thermometers with their stems graduated*—the only safe instruments for delicate experiments."

STANDARD THERMOMETERS.

Two important improvements in the Tubes and Scales of Thermometers and Barometers, first introduced by Negretti and Zambra, have become so extensively used that N. and Z. deem a short notice necessary to secure to themselves the credit of the inventions.

The first improvement is the introduction of a white Enamel at the back of Thermometer Tubes, which renders the mercury much more plainly visible both in large and small-bore tubes. Some of the extremely delicate Thermometers now in use would have been almost useless but for this enamelling.

This invention has also been applied to the back of Barometer Tubes.

The second invention is the use of Procelain for Scales and Dials of Thermometers, Barometers, &c., in place of Metal, Ivory, or Wood, all of which so soon become soiled and tarnished, and eventually the divisions and figures obliterated by the action of the atmosphere, sea-water, or damp. The divisions and figures on these Procelain Plates are etched in with fluoric acid, and the colour permanently burnt or melted in by fire. That these are important inventions may be inferred from their use in all thermometers and barometers supplied to the Board of Trade and other Government departments.

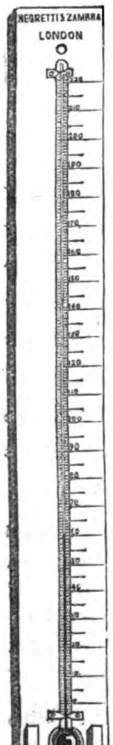


FIG. 28.

33. **Independent Standard Thermometer** (fig. 28), with Negretti and Zambra's Enamelled tube, and Engine divided into either Fahrenheit or Centigrade scales, the divisions engraved on its own stem and mounted on silvered brass, boxwood, or Negretti and Zambra's Patent Procelain scales.

N. & Z's Standard Thermometers are made from selected tubes, the internal diameter of which is ascertained by very carefully conducted experiments. They are also strictly tested for index error, and a copy of the corrections, if any, furnished with each instrument, if required.

Price, £5 5 0

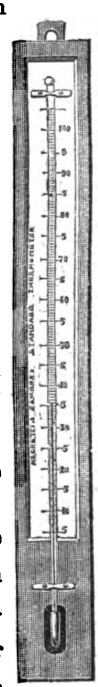


FIG. 29.

34. **Comparative Standard Thermometers** (fig. 29).—These Thermometers are made by comparison with great care, from an accurate standard, correct to $\frac{1}{10}$ of a degree. Engine-divided Enamelled Tubes mounted on Silvered Brass or Negretti and Zambra's Patent Porcelain scales, with Mahogany or Oak framing. *Price*, £2 2 0 and £2 10 0

We recommend the Standard Thermometers not to be mounted in any way, but the tube to be enclosed in a strong outer glass jacket; the bulb dipping

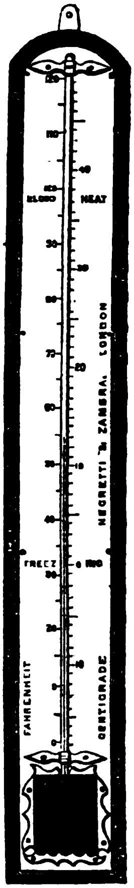


Fig. 30.*

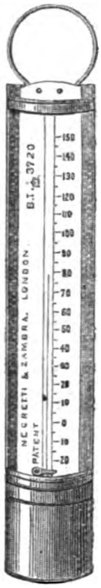


Fig 30.

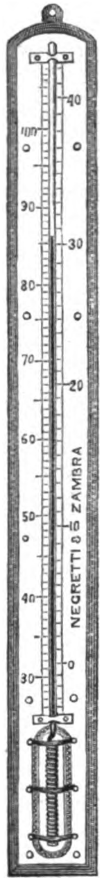


Fig. 31.

into a reservoir of mercury, and the whole hermetically sealed, as in our Standard Deep-sea Thermometers; by these means the bulb is effectually protected from the pressure of the atmosphere, either from Barometrical changes or difference in altitude, and the divisions on the stem are so covered by the outer glass tube that they cannot be effaced or become invisible.

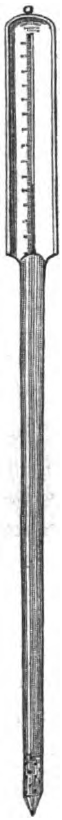
35. **Board of Trade Thermometer.**—It consists of a carefully compared thermometer with Negretti and Zambra's enamelled tube divided on its stem to degrees, which are sufficiently large to admit of subdivision into tenths of degrees, and ranging from 0° to 130°. The scale is of Negretti and Zambra's Patent Porcelain, having the figures etched upon it, and burnt-in a permanent black. It is a reliable comparative or reference thermometer, adapted for almost any

ordinary purpose; and cannot be injuriously affected by any chemical action arising from air or sea-water. (Fig. 30). This thermometer is employed in the Royal Navy and for the observations made at sea for the Board of Trade and Meteorological Department.

Price, in Neat Japanned Case	0	10	6
Ditto Copper Case	0	12	6
A set of 6 Ditto ditto, in Copper Cases, fitted in a Mahogany Box .	£2	10	0

36. **Thermometers of Extreme Sensitiveness.**—Negretti and Zambra's Instantaneous Thermometer, with Gridiron form of bulb, and divided upon the stem, as shown in the International Exhibition of 1862, used by Mr. Glashier in his balloon ascents to obtain very rapid thermometric readings. (Fig. 30.*)

Price, £3 3 0 *to* £6 6 0



37. **Thermometers, very delicate,** with Spiral or Coiled bulbs, engine-divided upon the stem, mounted on boxwood, metal or opal glass scales. Fig. 31.

Price, £2 2 0 *and* £3 3 0

38. **Earth Thermometer**—for ascertaining the temperature of the soil at various depths. The tube is about five feet long, enclosed in stout wood, protected and strengthened by metal mountings and a pointed cap. The scale is of Negretti and Zambra's Patent Porcelain with enamelled and burnt-in divisions and figures. Figs. 32 and 32*. *Price*, £1 15 0 *and* £2 2 0

39. Earth Thermometers in series for inserting into the ground at depths of 6 inches, 12 inches, 24 inches, 48 inches and 120 inches. These thermometers are arranged with a scale about 6 inches above the earth.

Price for the series £7 7 0

The temperature of the soil is a very important element in the consideration of climate especially in connection with the growth of vegetation.—"It has been calculated by Mr. Raikes, from experiments made at Chat Moss, that the temperature of the soil when drained averages 10° higher than it does when undrained; and this is not suprising when we find that 1lb. of water evaporated from 1,000 lbs. of soil will depress the whole by 10°, owing to the latent heat which it absorbs in its conversion into vapour."

FIG. 32*.

Faraday has calculated that the average amount of heat radiated in a day from the sun on each acre of earth in the latitude of London, is equivalent to that which would be produced from the combustion of thirteen thousand four hundred and forty pounds of coal.

FIG. 32.

"The extremes of temperature in the different climates of the

earth are widely separated from each other, and the range of the thermometer is always greatest in the interior of the continents within the tropics. Mr. Campbell, in the country of the Botchuanas, saw the thermometer at 8 a.m. at 28°, and at 84° at noon. Mr. Bruce records a temperature at Gondar of 113°. The thermometer at Benares rises to 118°; at Sierra Leone the thermometer on the ground has been seen to rise to 138°, and Humboldt gives many instances of the temperature of the torrid zone rising to 118°, 120°, and 129°. At one time he found the temperature of a loose coarse-grained granite, in the sun, 140.5. In the Dukhun at a height of 3,090 feet above the sea, Col. Sykes once saw the thermometer in the shade at 105°, the range of the thermometer generally being from 93°.9 to 40°.5."

Slightly beneath the surface of the earth in the tropics, Humboldt states temperatures of 162° and 134° are frequently noted, and in white sand at Orinoco 140°, whilst at the Cape of Good Hope under the soil of a bulb garden a temperature of 150° is recorded by Herschell. In China, the temperature of water of the fields was found to be by Meyer 113° and adjacent sand much hotter. These extremes of temperature, which would cause the specific gravity of the air to vary from 1167 to 863, may serve as a kind of measure of the disturbing causes which interfere with the velocity and local direction of atmospheric currents and other phenomena, the calculation of which has been founded upon mean results.—*Daniell's Meteorology.*

It is stated that *below the layer of constant temperature* (estimated at about 80 to 90 feet from the earth's surface), the temperature is found to increase one degree Centigrade for every 100 feet.

Negretti and Zambra's
Patent Self-registering Maximum Thermometer.

The only Instrument of the kind adapted for transmission to India and the Colonies.

40. Previous to the Great Exhibition of 1851, all persons interested in meteorological observations were constantly annoyed by the inconvenience arising from the imperfect construction of Maximum Thermometers; and although Messrs. Negretti and Zambra at that time exhibited one or two new forms of instruments, nothing new in *principle* was brought forward. A thermometer, *old in principle,* greatly improved by Negretti and Zambra, wherein a *bubble of air* caused a separation in the mercurial column to form an index, was exhibited by them; but as the air bubble at different temperatures assumed different lengths it was *not approved* by the Jury appointed to examine Meteorological Instruments. The instruments invented by Dr. Rutherford and Sixe, as Maximum Thermometers, had both proved inefficient for the purposes required; and, although the best and most correct forms of these were also exhibited by Negretti and Zambra, they still saw that a great want would be met if a perfect instrument could be invented to indicate *Maximum* temperatures, all the above being imperfect—Rutherford's from the tendency of the index to

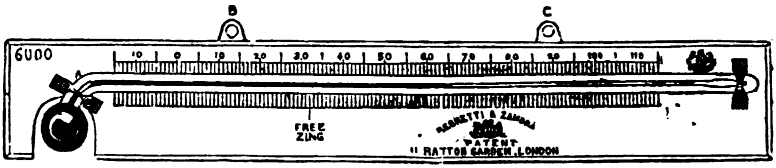


FIG. 33.

plunge in the mercury, Sixe's from the different expansive properties of the alcohol, mercury &c., of which it is composed, and the one already alluded to, not only from the defects before noticed, but also from its liability to resolve itself into an ordinary thermometer when used, unless in the hands of a skilful manipulator. How far the New Patent Maximum Thermometer of Negretti and Zambra has supplied all these deficiencies may be judged from the fact that in all the principal Observatories throughout the world it is used, *to the exclusion of all others, unless for the purposes of comparison.* They are now in the hands of all our most scientific men, and have given universal satisfaction. The simplicity of their construction enables the most uninitiated in thermometers to use them with confidence and safety; and another important feature in them is the impossibility of putting them out of order, for nothing short of actual breakage can in any way cause them to fail.

40* **Negretti and Zambra's Patent Self-Registering Standard Maximum Thermometer**, consists of a tube of mercury mounted on an engraved scale, as shown in fig. 33. The thermometer tube above the mercury is entirely free from air; and at the point (A) in the bend above the ball, is inserted and fixed with the blow-pipe a small piece of solid glass, or enamel, which acts as a valve, allowing mercury to pass on one side of it when heat is applied; but not allowing it to return when the thermometer cools. When mercury has been once made to pass the valve, which nothing but heat can effect, and has risen in the tube, the upper end of the column registers the maximum temperature. To return the mercury to the bulb, we must apply a force equal to that which raised it in the tube; the force employed is gravity, and is applied by simply lowering the bulb end of the thermometer, when the gravity of the mercury in the tube will be sufficient to unite it with that in the bulb, and thus prepare the instrument for future observation.

Price, mounted with Negretti and Zambra's enamelled tube and Patent Porcelain or Opal glass Scale, figs. 33 and 34 . . . . . £1 1 0

The following is an extract from the *Report of the Astronomer Royal*, published shortly after the invention of the instrument—it, however, applies more strongly now, inasmuch as the intervening years have fully proved the efficiency and value of this invention :—

* The whole of Negretti and Zambra's Standard thermometers have their improved enamelled back tubes and are Engine divided on the stem.

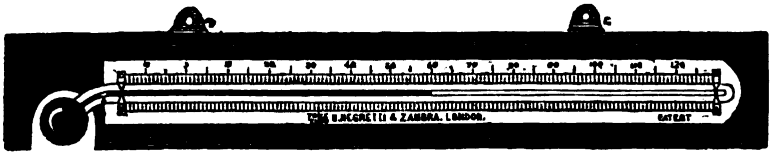


FIG. 34.

Report of the Astronomer Royal, May, 1852.

"We have for several years been very much troubled by the failures of the Maximum Self-Registering Thermometers, especially those exposed to the sun: the part of the tube in which the index ought to slide becomes foul, apparently lined with a coat of metal, and the index is immoveable. A construction invented by Messrs. Negretti and Zambra appears likely to evade this difficulty. The mercury in its expansion is forced past an obstruction in the tube, and does not return past in its contraction. No index is required in this construction. The specimens of this instrument which we have tried answer well."

In the *Quarterly Report of the Registrar General*, about the same time, there is the following annotation:—

"The form of instrument adopted during the past quarter for maximum temperature is that of Negretti and Zambra, which is found to act admirably."

J. GLAISHER, Esq., F.R.S., in his *Lectures on the Results of the Great Exhibition*, delivered at the Society of Arts, at the suggestion of his late Royal Highness the Prince Consort, when speaking of Meteorological Instruments (page 363) says:—

"In maximum and minimum thermometers there was nothing new exhibited, although great need had long existed for an effective Maximum Thermometer. Thanks to the exhibition, however, this want has since been supplied. Messrs. Negretti and Zambra have invented a thermometer, the construction of which is as follows: a small piece of glass is inserted in the bend, near the bulb and within the tube, which it nearly fills: at an increase of temperature, the mercury passes this piece of glass; but on a decrease of heat, not being able to recede, it remains in the tube, and thus indicates the maximum temperature. After reading, it is easily adjusted. Four of these instruments I have had at work for upwards of a month, two in ordinary observations, and two subject to severe tests, and all have answered admirably. Hitherto every series of meteorological observations has been more or less broken by the frequent plunging of the steel index into the mercury, or becoming otherwise deranged. Messrs. Negretti and Zambra have, in their Maximum Thermometer, supplied a want long felt."*

Extract from the *Report of the Council of the British Meteorological Society*, read at a General Annual Meeting of its Members, 1852:—

"Negretti and Zambra's Thermometer, for the determination of maximum temperature, is one of the good results of the Great National Exhibition, which proved itself, as regarded meteorological instruments, a most useful exponent of the insufficiency of those sold to the general public; *this Thermometer is the best which has yet been constructed for maximum temperatures, and particularly for sun observations;* for as the reading is determined by the entire mercurial column being detained at its highest point by a simple contrivance within the tube, the necessity for an index is avoided, and with it the constant and distressing recurrence of derangement attendant upon the employment of those generally in use. This thermometer, constructed and brought into operation since the close of the Exhibition, has been for some time in the hands of Members of the Council, but only recently among its meteorological contributors, from its having been esteemed desirable that the Council should be well informed, by actual experiment, of the well-working of the instrument before sanctioning its general circulation. Accordingly, in the early part of the year, for some months several of Negretti and Zambra's Maximum Thermometers were subjected by our Secretary to severe tests, and as the results were highly satisfactory, *the Council have not only viewed this instrument as an addition to the practical meteorologist, but strongly recommended its adoption and general use.*"

Copy from the *Report of the Kew Committee of the British Association*, 1853-4:—

"The very ingenious instrument of Messrs. Negretti and Zambra has one quality, which, as regards durability, places *it above every other form of Maximum Thermometer*, for when once well-constructed, it can never get out of order,—the observer having first satisfied himself as to its correctness, may ever afterwards use it with confidence, relying that his register will not be interrupted by any of those annoyances to which he may have been accustomed *in other forms of this instrument.*"

* The thermometers have now been used with equal satisfaction for twenty-five years.

The following is from the late JOHN DREW, Ph. D., F.R.A.S., Author of *Practical Meteorology, &c., &c.*

"GENTLEMEN,—In my opinion your Maximum Thermometer, as it becomes more generally known, will supersede every other. The *impossibility* of the index getting out of place, how much soever the instrument may be agitated, will always give it the preference over every other maximum thermometer with a moveable index."

From E. J. LOWE, Esq., F.R.A.S., F.G.S., &c., &c., to Messrs. NEGRETTI and ZAMBRA.

"GENTLEMEN,—It affords me the greatest pleasure in being enabled to speak with praise regarding your Patent Maximum Thermometer. I have used a dozen of them for some time at both my observatories, and of these several since the date of their invention. In no single instance has there been any cause of complaint. Within the last few months I have carefully tested them in various ways, yet always with the most satisfactory results. I can therefore say with truth that your patent instrument is the best Self-Registering Maximum Thermometer which has ever passed through my hands; indeed, no observer can do without it."

HIGHFIELD HOUSE OBSERVATORY, NEAR NOTTINGHAM,
September 1st, 1856.

M. J. J. JOHNSON, Esq., to Messrs. NEGRETTI and ZAMBRA.

"GENTLEMEN,—I beg to state that your meteorological instruments, with glass mountings and graduated stems, have been in use at this Observatory since February, and I have every reason to be satisfied with their performance, both as regards the ordinary and the self-registering instruments; the Maximum Thermometer, in the latter class, is one of your own invention and construction."

RADCLIFFE OBSERVATORY, OXFORD,
21*st August*, 1856.

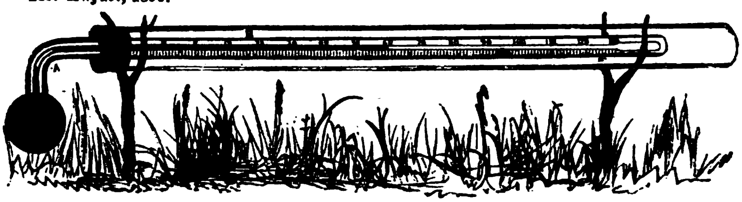


FIG. 35.

41. **Negretti and Zambra's Patent Solar Radiation Thermometer** (fig. 35).—Consists of a mercurial thermometer with a blackened bulb, the scale is engine divided on the stem, and the divisions protected by a glass shield. In use, it should be placed horizontally, with its bulb in the full rays of the sun, resting on grass, and, if possible, so that lateral winds should not strike the bulb. The directions for use are identical with those for the determining of the temperature of the air. Fig. No. 40*. *Price*, £1 1 0

42. **Negretti and Zambra's Patent Registering Clinical Thermometers** of various sizes and forms will be described in future section with prices and illustrations.

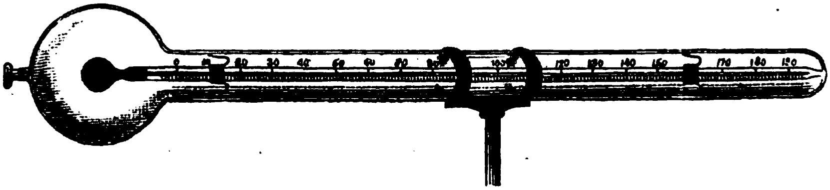


FIG. 36.

43. **Vacuum Solar Radiation Thermometer** (fig. 36).—This instrument consists of Negretti and Zambra's blackened bulb Radiation Thermometer, enclosed in a glass tube and globe, from which all air is exhausted, as suggested by Sir John Herschel in the Admiralty Manual of Scientific Enquiry, in 1849,

Thus protected from the loss of heat which would ensue if the bulb were exposed, its indications are from 20° to 30° higher than when placed side by side with a similar instrument with the bulb exposed to the passing air. At times when the air has been in rapid motion, the difference between the reading of a thermometer giving the true temperature of the air in the shade, and an ordinary solar radiation thermometer, has been 20° only, whilst the difference between the air temperature and the reading of a Radiation Thermometer in vacuo has been as large as 50°. It is also found that the readings are almost identical at distances from the earth varying from six inches to eighteen inches. By the use of this improved Solar Radiator the amounts of solar radiation at different places are rendered comparable; with the exposed bulb Thermometer, (fig. 35) the results could not be compared, as the bulbs of the thermometers would be under very different conditions as to exposure and currents of air. This new arrangement gives the readings very much more uniform, and is found to be a decided improvement. *Price*, £1 5 0

43. **Negretti and Zambra's Improved Solar Radiation Vacuum Thermometer, with Mercurial Test Gauge.** (Fig. 37.)

For some many years most important investigations have been in progress in connection with Solar Heat, and as it is evident that all such inquiry should be carried out with the utmost precision, a question arose as to the perfection of the Vacuum in different Solar Radiation Thermometers, and hence a ready means of testing these instruments became desirable for the purposes of comparison

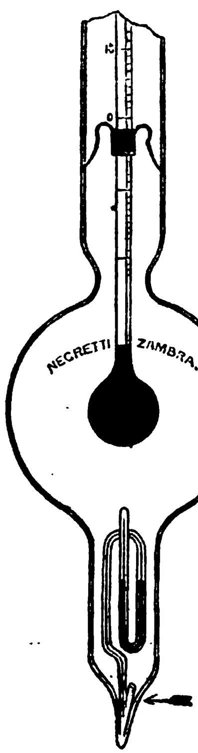


FIG. 37.

Although this want had been repeatedly pointed out, no attempt had been made to remedy the defect. At last, we produced a Solar Radiation Thermometer with a small mercurial vacuum gauge inside the outer covering, which gives the exact amount of vacuum, or, it might more properly be called, the exact amount of air left in the space around the thermometer. The insertion of this small test guage in the manner that it has been effected, is one of the most beautiful arrangements ever effected by the skill of the glass-blower. As a matter of course, having pointed out the road, other tests were devised. Among others, an electrical test, by inserting metal wires and connections in the two ends of the glass shield, by which a current of elec-

tricity from a Rhumkorf's Induction Coil can be passed through the tube, and the colour, etc., etc., of the electric discharge be observed. This test has two defects, viz., that coils and batteries are not always available, and also that the metal connections in the glass tube are very liable to fracture, and consequent leakage of air into the tubes from the cracking of the glass around the wires.

We need hardly observe that this is a most important invention and improvement, for, without satisfactory evidence of the perfection of the vacuum, strict experiment cannot be carried out. *Price*, £1 16 0

44. **Wood Stand for Negretti and Zambra's Patent Vacuum Solar Radiation Registering Thermometer**, for experiments at four feet from the ground. Suggested and recommended by the Rev. F. W. Stow, who advises that the Bulb end of the Thermometer should be placed facing the S.E., and in such a manner that the air may circulate freely round it. Strict shade temperature should also be noted by a good Thermometer, so as to obtain the maximum in sun and shade, and from these the amount of Solar Radiation may be deduced. A wood engraving of this Thermometer stand will be found with others at the end of the Meteorological section, page 55. *Price*, £1 1 0

45. **Negretti and Zambra's Patent Self-Registering Maximum Thermometer**, for recording the Temperature of Mines, Thermal or Boiling Springs, Atmospheric or Earth Temperature, &c., &c.

This Thermometer has its scale divided and figured upon the stem, the REVERSE of an ordinary Thermometer—the reading *commencing* from the *end* of the tube and *not* at the bulb. The stem or tube is mounted in and protected by a stout glass shield, the bulb of the Thermometer being uppermost, and all mercury passing the bend or contraction in the tube will by gravity, fall to the opposite end, and be detained and measured. The whole instrument is conveniently mounted in a round copper or brass case, with a handle or ring attached to the top for suspending the Thermometer.

In use, the Instrument is suspended by the ring attached to the top of the metal mounting, and as it enters a heated atmosphere the mercury in the bulb expands into the tube, passing the *bend* or *contraction** near the bulb; whatever quantity of mercury passes the bend will remain in the tube, and *not recede when the temperature cools;* should thirty or forty degrees of mercury pass, it will of its own weight, fall to the end of the tube; should it *not do so*, hold the Thermometer in an *oblique* position, the *bulb end being lowest* so that the mercury in the tube may *very gradually* descend until it touches any mercury at the bend,† if now the bulb end be raised the mercury will again descend carrying with it any small particles that have passed the bend. When the mercury has all been collected at the end of tube, read off in degrees on the thermometer scale its indication, and that will be the Maximum Temperature.

* Sometimes a bend and sometimes a contraction is used to separate the indicating mercurial column.

† The tube should not be held upright, or portions of the mercury may pass by the bend into the bulb.

To re-set the Thermometer hold it *bulb downwards*, and swing it backwards and forwards, to force back the excess of mercury, beyond the present temperature, into the bulb. This precaution should *always* be observed before commencing to take an observation.

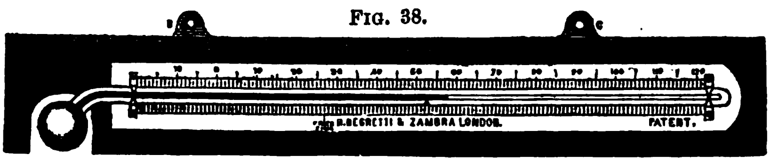
Price, in Strong Metal Mounting, £1 10 0

In our Section, "Thermometers for Special Purposes," will be found woodcuts of several forms of these Instruments, with further details as to their construction and use.

The following extract from the Fourth Report of the Committee on Underground Temperature, British Association for Advancement of Science, 1871, will sufficiently prove the advantages of Negretti and Zambra's Patent Maximum Thermometer without further comment:—

"The Thermometer which the Committee have been employing for the last three years is a Phillips's Maximum, having so fine a bore that the detached column of mercury which serves as the index is sustained in the vertical position by capillary action, and will bear a moderate amount of shaking without slipping down. Numerous instances, however, have occurred in which the *index has slipped* in consequence of jerks or concussions sustained by the thermometer in hauling it up from a depth. During the past six months the Secretary has been in correspondence with Messrs. Negretti and Zambra respecting a proposed modification of the Maximum Thermometer known by their name, which occurred to him more than a year ago, and was described by him privately to some meteorological friends at the last Meeting of the Association. It was then supposed to be new, but it now appears that Messrs. Negretti and Zambra have made something of the kind for the last fifteen years. Several changes, however, were necessary before the thermometer was adapted to the uses of the Committee, and the first complete instruments were received in June last. They are enclosed, like the thermometers previously used, in hermetically sealed tubes, for protection against pressure, and they have the advantages (1) *of being able to bear severe jolts without derangement of their indications, and* (2) *of presenting to view a much broader column of mercury, so as to be more easily read in a dim light.*

FIG. 38.



46. **Negretti and Zambra's Standard Minimum Thermometer.** (Fig. 38.) consists of an enamelled glass tube, the bulb and parts of the bore of which is filled with perfectly pure colourless Spirits of Wine, in which floats freely a black glass index. The tube is engine divided and mounted as shown in fig. 38 on either N. and Z.'s patent Procelain or Opal Glass Scales.

Directions for using Minimum Thermometers, for the Determination of the Minimum Temperature of the Air.—Having caused the black index to flow to the end of the column of spirit, by slightly tilting the Thermometer, bulb uppermost, suspend the instrument, (*in the shade* with the air passing freely to it on all sides) by the two plates attached for that purpose,—in such manner that the bulb is about half an inch lower than the end of the Thermometer furthest from the bulb,—then on a *decrease* of temperature, the spirit will

descend, carrying with it the index towards the bulb; on an *increase* of temperature, the spirit will ascend in the tube beyond the index, leaving that end of the index furthest from the bulb indicating the extreme of cold or minimum temperature. To re-set the instrument, simply raise the bulb end of the Thermometer a little, as before observed, and the index will again descend to the end of the spirit, ready for future observation.

Price, in mounting as fig. 38, £1 1 0

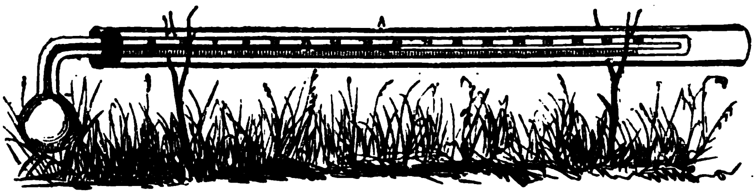


FIG. 39.

47. **Negretti and Zambra's Standard Terrestrial Radiation Thermometer.** (fig. 39).—The bulb of this instrument is transparent, with the divisions engraved on its stem similar to that for solar radiation. In use, to be placed with its bulb fully exposed to the sky, resting on grass, with its stem supported by little forks of wood. *Price*, £1 1 0

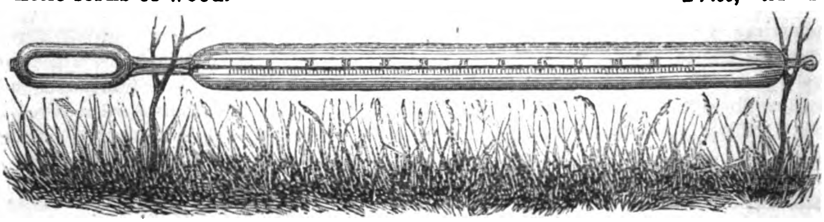


FIG. 40.

48. **Negretti and Zambra's Link shaped Bulb Minimum Thermometer,** mounted either as a Terrestrial Radiation instrument, fig. 40, or on a Porcelain scale as fig. 38. This peculiar form of bulb was devised by Negretti and Zambra to obtain extreme sensitiveness by the large surface exposed to air.

Price, £1 5 0

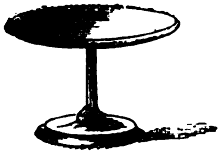


FIG. 42.

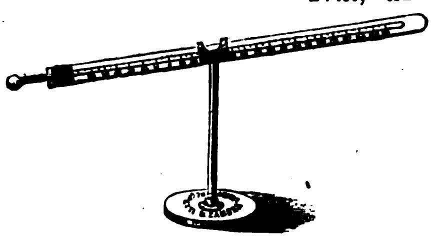


FIG. 41.

49. **Negretti and Zambra's Minimum or Terrestrial Radiation Thermometer** with Brass Stand. (fig. 41). *Price*, £1 5 0

50. **Concave Metallic Reflector** on a Brass Stand for use with Terrestrial Radiation Thermometer (fig. 42). *Price*, 5s. 6d.

N.B.—As Alcohol Thermometers have a tendency to read lower by age, owing to the volatile nature of the alcohol allowing particles in the form of vapour to rise and lodge in the tube, it becomes necessary to compare them occasionally with a mercurial thermometer whose index error is known; and if the difference be more than a few tenths of a degree, *examine well the upper part of the tube* to see if any alcohol is in the bore, if so, detached portions can be joined to the main column by swinging the thermometer sharply backwards and forwards with a pendulous motion, keeping the *bulb downwards*. When all the detached portions are joined, allow it to stand upright for an hour before again suspending it for observations.

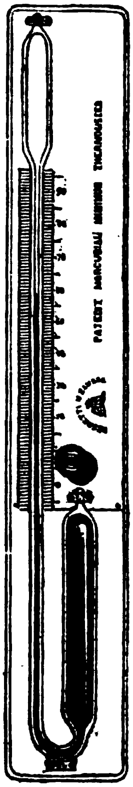
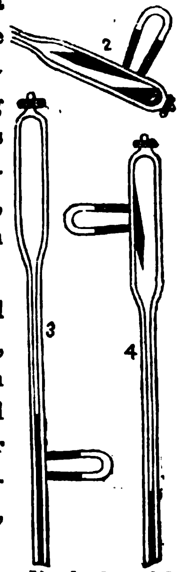


FIG. 43.



51. **Negretti and Zambra's Patent Mercurial Minimum Thermometer,** represented by fig. 43, has a cylindrical bulb of large size. The reason for having the bulb large is to allow the internal diameter of the thermometer tube to be greater than that generally used for thermometrical purposes, so that a steel index, pointed at both ends, may move freely within when required.

In use, the Thermometer is suspended perpendicularly with the steel index resting on the surface of the mercurial column. As the mercury in the cylinder contracts from the effect of cold, that in the tube descends, and the index, of its own gravity, follows it; on the contrary, as the mercury expands and rises in the tube, it passes the index on one side, and in rising, exerts a lateral pressure on the needle, and jams it to one side of the tube, where it remains firmly fixed, leaving the upper point of the needle indicating the minimum temperature. In this thermometer, the reading is always from the upper point of the needle, and not from the mercury itself.

To extricate the needle from the mercury, a magnet is used, when, if the needle is embedded only a few degrees, it can readily be withdrawn without altering the position of the instrument. Should the magnet not be sufficient for the purpose, we simply turn the thermometer from the upright position, slightly elevating the bulb (fig. 2). The mercury and index will then flow into the small reservoir (D). Should the index not freely leave the tube with the mercury, assist it with a magnet and when the mercury and index are in the upper bulb (fig. 2), apply a magnet outside, which will attract and hold fast the index; and whilst thus holding it, again bring the thermometer to the upright position, when the mercury will immediately fall back into the tube,

leaving the index attached to the magnet (fig. 4), with which it is guided down to the surface of the mercury, ready for another observation.

Price, £2 10 0

The value of these instruments may be estimated from the following letters, received from gentlemen by whom the thermometers have been tested since their invention.—

"LEWISHAM, 1856, February 27.

"GENTLEMEN,—In reply to your note just received, I beg to say that your new Mercurial Minimum Thermometer was suspended by the side of two Minimum Thermometers of the best kind of the ordinary construction, on the day I received it from you, viz, 1855, November 21, and it has been examined and read every day since, during which interval of time the temperature has varied from 15° to 60°. It has acted equally well within this range. In the course of the experiments, it was found that at times differences amounting to 2° and 3° existed in the minimum readings between those of the new mercurial and old spirit thermometers. These differences were found due to two causes. The one occurred at low temperatures, and on reference to independent registers, it was found that the readings of the mercurial were right, the difference being attributable to the sluggishness of the alcohol; and, in the other case, it was found that the index of the ordinary thermometer had unduly moved towards the bulb, the instrument having been shaken by the wind.

"I consider the new Minimum Thermometer a very important addition—indeed a more important one than the Maximum Thermometer of your invention, as by its means we can register all observations of temperature by the use of one fluid, and that the recognised standard for the measurement of heat.

"With respect to your Maximum Thermometer, it acts admirably, and leaves scarcely anything to be desired. It has never been out of order during the four years* I have had it in constant use, and it does not seem possible to put it out of order, except by the destruction of the instrument.

"I am, Gentlemen, your obedient Servant,

"JAMES GLAISHER, F.R.S.

"Messrs. NEGRETTI and ZAMBRA, Opticians." "Secretary to the British Meteorological Society.

The following is an extract from a letter to the inventors, Messrs. NEGRETTI and ZAMBRA, from E. J. LOWE, Esq., dated *Observatory, Beeston, near Nottingham* :—

"Your Patent Mercurial Thermometer is an admirable invention. I have worked it to my entire satisfaction. I have tested its usefulness in many different ways, every one of which has been perfectly satisfactory. It is certainly a meteorological triumph for which meteorologists must return you thanks."

The following is an extract from a paper read by Dr. LEE, President of the British Meteorological Society, before the British Association, Cheltenham, August 11th, 1856, when the Mercurial Minimum Thermometer was exhibited :—

"Dr. Lee observed, that one of these thermometers had been in the hands of the Secretary of the British Meteorological Society; another at the Royal Observatory, Greenwich; a third at Mr. E. J. Lowe's Observatory, Highfield House; and others had been used by various members of the British Meteorological Society, all of which had acted most accurately, and in two instances had corrected errors in the alcohol minimums *which otherwise would have passed unnoticed*."

Care must be taken not to withdraw the magnet until the index is in contact with the mercury, for, if released before touching, it might plunge too deeply and give a false indication. The rule for re-setting it will be to bring the needle-point in contact with the mercury, and then withdraw the magnet, having previously ascertained that no particles of mercury are attached to the index.

It may sometimes, though rarely, happen that, from the time a minimum temperature is registered by the index, and the time an observation is made, the mercury may have risen so high in the tube as to completely pass the

* It is now more than twenty years, and still the thermometer is perfect.

index, as shown (fig. 3). Should it so happen, the space which the index occupies will readily be observed, as it will be pressed to one side of the tube, causing a different appearance in that part, although the point of the needle may not be seen. If such be the case, apply a magnet to the spot where you see the index is fixed: this will hold the needle firmly. Then, by slightly tilting the thermometer bulb uppermost, the mercury will flow into the top bulb, leaving the index attached to the magnet, and quite uncovered. Having taken the reading, draw the needle into the top bulb, and hold it there whilst you adjust the thermometer by again bringing it to the upright position.

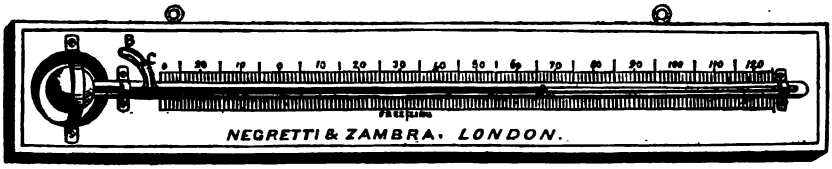
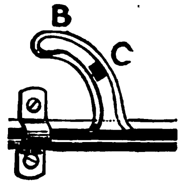


FIG. 44.

52. **Negretti and Zambra's Patent Mercurial Minimum Thermometer.** The Patent Mercurial Minimum Thermometer is constructed as follows: A is the thermometrical or indicating tube, and B is a small vertical tube connected to it at right angles, about one inch from the ball. In the tube B, at the point C, is inserted a platina plug, which does not entirely fill the bore, as may be seen by elevating either end of the instrument, as the mercury will then flow in the tube A, either to or from the bulb, depending upon which end of the thermometer is elevated or depressed.



To set for Observation, and use the Patent Mercurial Minimum Thermometer.—Hold the thermometer with the bulb downwards until the bulb and tube B are quite full of mercury; then raise the bulb end of the thermometer, and the mercury will flow from the tube B into the tube A, until it reaches the plug C, where it will be checked by the mercury adhering to the platina plug—the affinity of platina for mercury being sufficient to arrest the flow of mercury, if not allowed to flow too rapidly. Should it overshoot the mark and go to the end of the tube A repeat the operation more carefully.

Suspend the thermometer horizontally, and on a *decrease* of the temperature the mercury will fall in the tube A until it attains its minimum temperature; and on an *increase* of temperature the mercury will rise in the tube B, leaving the indicating column in A, registering the extreme degree of cold, or minimum temperature. To re-set the instrument for future observation, simply raise the bulb end of the thermometer until the mercury again comes in contact, and is checked, by the platina plug.

This form of Mercurial Minimum Thermometer has one very great advantage over the preceding instrument, viz., it is much less liable to injury or breakage in transit. *Price*, fig. 44. £2 2 0

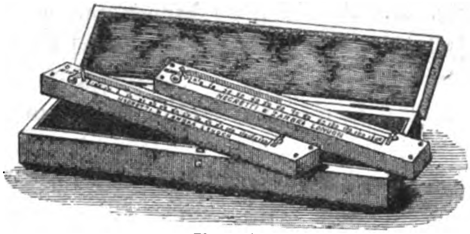


FIG. 45.

53. **Portable Patent Maximum and Minimum Registering Thermometers.**— Negretti and Zambra's Small Patent Maximum and Minimum Registering Pocket Thermometers, fitted into a secure and convenient mahogany or leather case, special for travellers. (Fig. 45.) *Price* £2 2 0

Larger Standard size ditto 2 10 0

The construction and use of the Portable Registering Thermometers is identical with N. and Z.'s larger Standard instruments, Nos. 40* and 46. These are the only Registering Thermometers that will travel without derangement. Explicit printed instructions for use accompany each set of instruments.

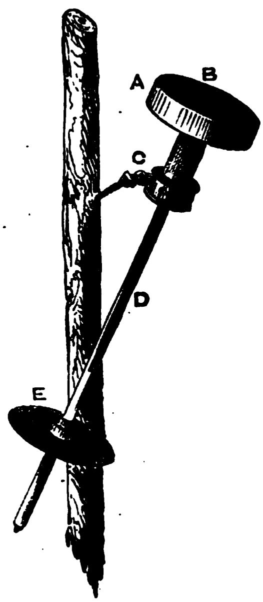


FIG. 46.

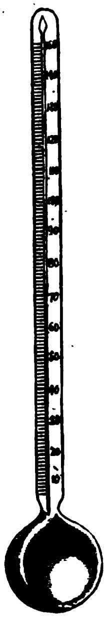


FIG. 49.

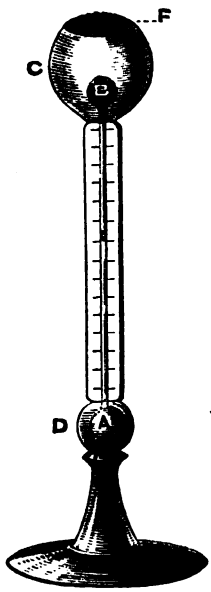


FIG. 47.

54. **Pyrheliometer** (Pouillett's) (fig. 46), for ascertaining the effect of the sun's heat upon a given area by the number of degrees of heat imparted to mercury in five minutes. *Price,* £5 5 0

NOTE.—All of Negretti and Zambra's Standard Thermometers may be had with Centigrade or Reaumer Scales to order.

This instrument is composed of a shallow cylinder of steel, *A*, fig. 46, which is filled with mercury. Into the cylinder a thermometer, *D*, is introduced, the stem of which is protected by a piece of brass tubing. We thus obtain the temperature of the mercury. The flat end of the cylinder is to be turned towards the sun, and the surface, *B*, thus presented is coated with lamp black. There is a collar and screw, *C*, by means of which the instrument may be attached to a stake driven into the ground, or into the snow, if the observations are made at considerable heights. It is necessary that the surface which receives the sun's rays should be perpendicular to the rays; and this is secured by appending to the brass tube which shields the stem of the thermometer, a disk, *E*, of the same diameter as the steel cylinder. When the shadow of the cylinder accurately covers the disc, we are sure that the rays fall, perpendicular, on the blackened surface of the cylinder.

"The surface on which the sun's rays here fall is known; the quantity of mercury within the cylinder is also known; hence we can express the effect of the sun's heat upon a given area, by stating that it is competent, in five minutes, to raise so much mercury so many degress in temperature."—*Dr. Tyndall's "Heat considered as a Mode of Motion."*

55. **Æthrioscope** (Leslie's) (fig. 47.) The celebrated philosopher, Sir John Leslie, was the inventor of this instrument, the purpose of which is to give a comparative idea of the radiation proceeding from the surface of the earth towards the sky. It consists, as represented in fig. 47, of two glass bulbs united by a vertical glass tube, of so fine a bore that a little coloured liquid is supported in it by its own adhesion, there being air confined in each of the bulbs. The bulb, A, is enclosed in a highly polished brass sphere, *D*. The bulb, *B*, is blackened and placed in the centre of a metallic cup, *C*, which is well gilt on the inside, and which may be covered by a top, *F*. The brass coverings defend both bulbs from solar radiation, or any adventitious source of heat. When the top is on, the liquid remains at zero of the scale. On removing the top and presenting the instrument to a clear sky, either by night or by day, the bulb, *B*, is cooled by terrestrial radiation, while the bulb, *A*, retains the temperature of the air. The air confined in *B*, therefore, contracts; and the elasticity of that within *A* forces the liquid up the tube, to a height proportionate to the intensity of the radiation. Such is the sensitiveness of the instrument, that the smallest cloud passing over it checks the rise of the liquid. *Price*, £1 10 0

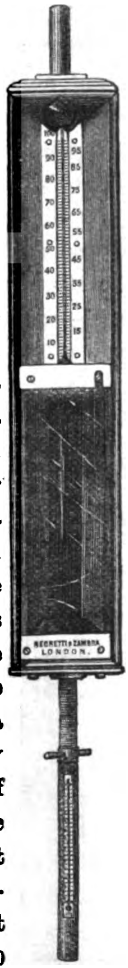


FIG. 48.

56. **Actinometer, Sir John Herschell's** (fig. 48), for ascertaining the absolute heating effect of the solar rays, in which *time* is considered

one of the elements of observation. The Actinometer consists of a large cylindrical thermometer bulb, with a scale considerably lengthened, so that minute changes may be easily seen. The bulb is of transparent glass, filled with a deep blue liquid, which is expanded when the rays of the sun fall direct on the bulb. To take an observation, the Actinometer is placed in the shade for one minute, and read off, it is then exposed for one minute to sunshine, and its indication recorded; it is finally restored to the shade, and its reading noted. The mean of the two readings in the shade, subtracted from that in the sun, gives the actual amount of expansion of the liquid produced by the sun's rays in one minute of time. For further information see "*Report of the Royal Society on Physics and Meteorology.*" *Price,* £7 7 0

57. **Negretti and Zambra's improved Isolated Glass Mountings for protecting Thermometer Scales from moisture.** Many observers having found much trouble in reading the indications of Terrestrial Radiation and exposed Thermometers from the condensation of moisture on the inside of the protecting glass tubes or shields. Messrs. Negretti and Zambra have succeeded in perfecting a method of mounting up such instruments that quite obviates the difficulty. This improvement consists in so melting an external glass cylinder round both ends of the thermometer as to render the shield perfectly air-tight, in fact, to hermetically seal up the instrument in it—so that no moisture can possibly accumulate inside the tube whilst the bulb of the thermometer is perfectly exposed to the air.

Negretti and Zambra are now applying this improvement with great advantage to Thermometers, Hygrometers and many other instruments required for out of door exposure.

These isolating mountings will make a slight addition to the cost of such Thermometers.

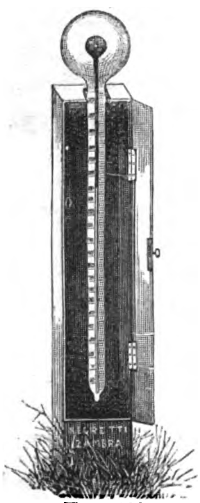


FIG. 48*.

58. Fig. 48* shews a new arrangement of Negretti and Zambra's Patent Solar Radiation Maximum Thermometer in vacuo. It will be seen in the woodcut that the bulb of the Thermometer is exposed to the sky in a vertical position with its stem enclosed by a light case or box. The scale is on the stem of the Thermometer, but, as in No. 45, this scale is figured the *reverse* of an ordinary instrument, the reading *commencing* from the *end* of the tube and *not* at the bulb. This arrangement has been introduced by N. & Z. to meet some requirements in connection with observations on solar temperatures where it has been supposed that a perfect sphere presented to the solar rays would give far more accurate indications than a bulb having projections such as seen in figs. 36 and 37.

Price, £1 15 0

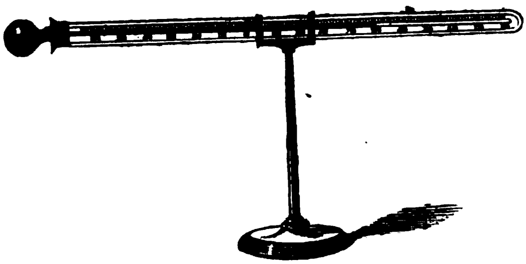


FIG. 50.

59. **Negretti and Zambra's Patent Registering Maximum Thermometer** with either *black* or *bright* bulbs for experiments on *radiant* or *reflected* heat, the scale divided on the stem, mounted on a brass stand. Fig. 50. *Price*, £1 10 0

60. **Mercurial Thermometer, with large Cup shaped Bulb,** (fig. 49), convex on the one side and concave on the other, exposing a very large surface, suited for experiment on Radiant or Accumulated Heat.

Price, Engine divided on the Stem . . . £1 5 0

61. **Negretti and Zambra's Patent Marine Maximum Thermometer.** As all other Marine Thermometers are liable to give false indications from the movements of the vessel in rough weather, this instrument becomes a most important improvement. It is constructed and used in a similar manner to No. 45, the bulb of the Thermometer being uppermost; and no oscillation, however violent, can disturb the indications. It is mounted in a strong wood or metal frame, suitable for sea service. *Price*, £1 1 0

62. **Helio-Pyrometer.** Mr. T. Southall, of Birmingham, has published some very remarkable results obtained with a Standard Maximum Registering Thermometer, having a Blackened Bulb placed within a shallow box lined throughout with black velvet, and having a soft cushion of the same material in the bottom. Upon this cushion the Thermometer is to be placed, and covered over as closely as possible by a piece of plate glass. Thus arranged, Accumulated Sun Temperatures have been noted by Mr. Southall varying from 216 to nearly 232 degrees of temperature. In fact Mr. S. states he has, with this apparatus, caused Water *to boil* rapidly by Solar Heat.

Negretti and Zambra's Patent Maximum Thermometer will be found eminently suited for experiment with the Helio-Pyrometer, as there is no fear of the Thermometer being spoilt by derangement of the index, as is the case with both Rutherford's and Phillips's instruments.

Price of complete Apparatus with N. and Z.'s Patent Maximum Thermometer £2 2 0

Extract from the *Report of the Council of the British Meteorological Society*, read at a General Annual Meeting of its Members, 1852:—

"Negretti and Zambra's Thermometer, for the determination of maximum temperature, is one of the good results of the Great National Exhibition, which proved itself, as regarded meteorological instruments, a most useful exponent of the insufficiency of those sold to the general public; **this Thermometer is the best which has yet been constructed for Maximum temperature, and particularly for Sun observations,**

INSTRUMENTS FOR ASCERTAINING THE HUMIDITY OF THE ATMOSPHERE.

The instruments used for observing the amount of moisture contained in the atmosphere are called Hygrometers. They are without doubt of all Meteorological instruments the most useful and valuable.

To ascertain with exactness the Hygrometric condition of the air is of the utmost importance both to the Physician and Agriculturist. By observing the varying amount of vapour or moisture in the air, the one is enabled to regulate its condition as best suited to his patient's requirements, and the other by closely watching the movements of the Barometer in connection with the Hygrometer can anticipate probable atmospheric changes that may prove beneficial or injurious to his crops.

There are many Hygrometers constructed as Weather Indicators only, simply showing the approximate condition of the air if it be wet or dry. Such instruments, however ingenious, are not of any scientific value. For more exact and precise observation the Hygrometers of Daniell, Regnault and Mason are chiefly used—the latter, viz., Mason's, from its extreme simplicity is now universally in use, and in connection with the valuable tables compiled by James Glaisher, Esq., F.R.S., the dew point can be ascertained with great exactness and ease.

In connection with the Hygrometer, the dew point will be frequently spoken of. This may be described in a few words as the amount of water which the air can sustain in an invisible form increasing with the temperature; but for every definite temperature there is a limit to the amount of vapour which can be thus diffused. When the air is cooled the vapour present may be more than it can sustain; part will then be condensed either in the form of dew, rain, hail or snow. The temperature which the air has when it is so fully saturated with vapour that any excess will be deposited as dew, is called the *dew-point.*

"To measure the quantity of dew deposited each night, an instrument is used called a *Drosometer.* The most simple process consists in exposing to the open air bodies whose exact weight is known, and then weighing them carefully when covered with dew. According to Wells, locks of wool, weighing about eight grains, are preferred, divided into spherical masses of the diameter of about two inches."—*Kœmtz.*

63. **Saussure's Hygrometer** (fig. 51), for showing changes in the hygrometric condition of the atmosphere on a graduated arc, by the contraction and elongation of a human hair, this acting the reverse of string or cord, stretching when moist and contracting when dry. A thermometer is attached to the scale.

Price, £1 10 0

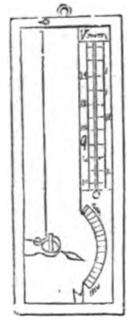


FIG. 51.

Although a most elaborate Treatise on the construction and use of this Hygrometer was written by its inventor, M. Horace Benedict de Saussure, Professor of Philosophy, at Geneva, in 1783, this instrument may be regarded more as an ornamental curiosity than of any scientific value.

64. **Leslie's Thermometric Hygrometer** (fig. 52). It will be seen that Leslie's instrument is the elementary form of Mason's Wet and Dry Bulb Hygrometer by which it is entirely superseded.

This instrument consists of a glass tube, terminated with a bulb at each end, as fig. 52. The tube is partly filled with sulphuric acid, tinged by carmine. One of the balls is covered with muslin, and kept continually moistened with water, drawn from a vase placed near it by the capillary attraction of a few strands of cotton-wick. The descent of the coloured liquid in the other stem will mark the diminution of temperature caused by the evaporation of the water from the humid surface. The drier the ambient air is, the more rapidly will the evaporation go on; and the cold produced will be greater. When the air is nearly saturated with moisture, the evaporation goes on slowly; the cold produced is moderate, because the ball regains a large portion of its lost heat from surrounding bodies. The degree of refrigeration of the ball is an index of the dryness of the air.

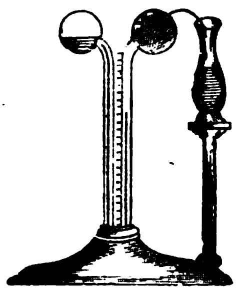


FIG. 52.

When this hygrometer stands at 15°, the air feels damp; from 30° to 40°, we reckon it dry; from 50° to 60°, very dry; and from 70° upwards, we should call it intensely dry. A room would feel uncomfortable, and would probably be unwholesome, if the instrument in it did not reach 30°. In thick fogs it keeps almost at the beginning of the scale.

Price, £1 1 0

65. **Daniell's Hygrometer**, for ascertaining the dew-point by direct observation (fig. 53), invented about the year 1820, by the late Professor Daniell, of King's College, London.

It consists of a glass tube, bent twice at right angles, and terminating, at each end, in a bulb. In the long limb of the tube is enclosed a delicate thermometer, which descends to the centre of the bulb, which is about three-parts filled with sulphuric æther. All the other parts of the tube are carefully freed from air, so that they are occupied by the vapour of the æther. This bulb is made of black glass the other bulb on the shorter limb is transparent, and

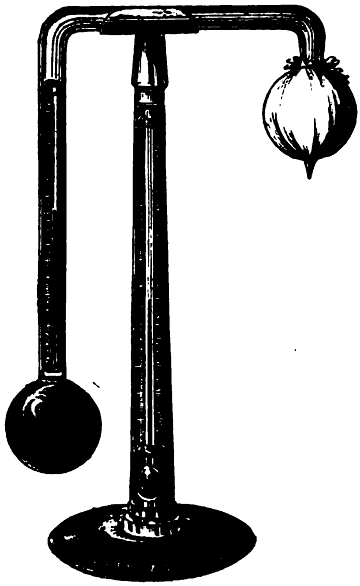


FIG. 53.

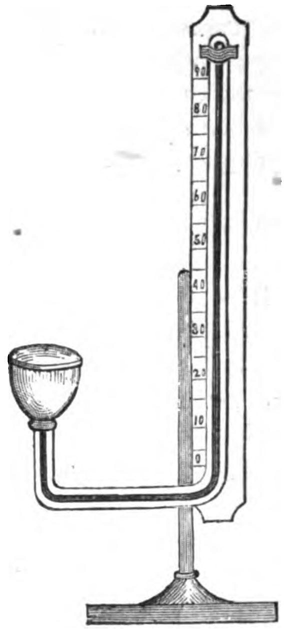


FIG. 54.

covered with a piece of fine muslin. The support for the tube has a delicate thermometer attached, to show the temperature of the external air.

This instrument gives the dew-point by direct observation, and is to be used at an open window facing the north in the following manner:—Having fixed the tube upon the stand, with the bulbs vertically downward, the Æther is all caused to flow into the lower ball by inclining the tube. The temperature of the air is noted by the exposed thermometer. Then some Æther is poured upon the muslin-covered bulb. The rapid evaporation of this Æther cools the bulb and causes condensation of the Æthereal vapour in its interior. This gives rise to rapid evaporation of the Æther in the lower bulb, whereby its temperature is greatly reduced. The air in the vicinity is deprived of its warmth by the cold bulb, and is soon cooled to the temperature at which it is perfectly saturated with the vapour which it contains. Cooled ever so little below this temperature, some aqueous vapour will be condensed, and will form a dew upon the black-glass bulb. At the first indication of the deposit of dew the reading of the internal thermometer is taken: which is the dew-point. In very damp or windy weather the Æther should be slowly dropped on the bulb, otherwise the descent of the mercury in the Thermometer is so rapid as to render it difficult to be certain of the temperature. Should this occur, the observation may be repeated by watching the temperature at which the ring of dew disappears, the mean of the two readings will be the correct point of precipitation. The greatest difference observed by Mr. Daniell in the course of four months' daily experiments between the external thermometer and the internal one at the

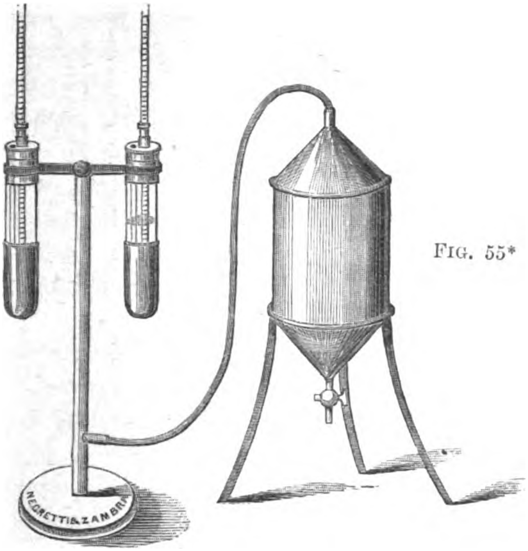


FIG. 55*

FIG. 55.

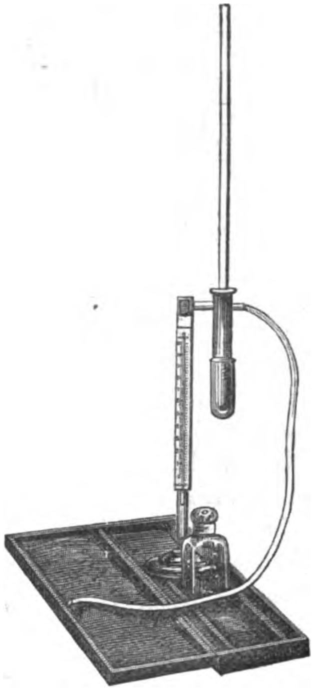


FIG. 56.

moment of precipitation in the natural state of the atmosphere was twenty degrees. When Daniell's Hygrometer is required to act merely as a weather-glass, to predict the greater or less probability of rain, &c., the difference between the constituent temperature of the vapour (shown by the interior thermometer), and the temperature of the air (shown by the exterior thermometer), is all that is necessary to be known. The probability of rain or other precipitation of moisture from the atmosphere, is in inverse proportion to this difference. There are several difficulties connected with the use of Daniell's Hygrometer that are in a great measure overcome in Regnault's Instrument.

66. **Jones's Hygrometer** (fig. 54.) This instrument is the same in principle as Daniell's Hygrometer, but simpler in its construction. The tube of the Mercurial Thermometer is bent so as to bring its bulb vertical and parallel with its stem. This bulb is one inch long, and of a conical shape, with a flattened top or surface of black glass projecting a little beyond the sides. Below the flat surface this bulb is covered with black silk. The Hygrometer is mounted and supported on a brass stand in such a manner that the black surface can be inclined towards the light. When used the temperature of the air is first to be noted. Æther is to be poured on to the silk cover of the bulb, and the condensation of moisture takes place upon the black surface of the bulb. Then, by again noting the temperature, the dew point may be known.

Price, £2 10 0

67. **Regnault's Condenser Hygrometer,** (fig. 55), for ascertaining by direct observation the dew-point, is superior to Daniell's, from its being more certain in its indications, and economical in use. It consists of two highly-polished silver cylinders, into the upper part of which are cemented thin glass tubes; these have brass covers, arranged to receive and support two delicate Standard Thermometers, the bulbs of which descend nearly to the bottom of the silver portion of these chambers. Each chamber has a small internal tube carried down from the brass cap to within a short distance of the bottom, to admit the passage of the air, which is drawn through both chambers by an Aspirator, (fig. 55*) connected to the base of the hollow upright and arms supporting the cylinders.

To use this Hygrometer, æther is poured into one chamber sufficient to cover the bulb of the thermometer, and then the thermometers being inserted into both cylinders the instrument is now connected to the aspirator, and by it the air is drawn through both cylinders down the internal tubes, passing in one chamber in bubbles through the æther, and in the other chamber simply around the thermometer. The tube in this empty cylinder is of such a diameter as to ensure similar quantities of air passing through each chamber.

After a short time the passage of the air through the æther will cool it down to the dew-point temperature and the external portion of the silver chamber containing the æther will become covered with moisture. The degree shown by the thermometer in the æther at that instant will be the temperature of the dew-point; the second thermometer showing the temperature of the air at the time of observation.

Price, in case £5 5 0

Aspirator for ditto (fig. 55*) . . . . £1 15 0 to 2 15 0

67. **Regnault's Condenser Hygrometer** (fig 56.), of simpler form, only one cylinder or chamber being used. The air in this arrangement is blown through the æther by the mouth. A small thermometer is attached to the stand to show the temperature of the external air.

Price, in Case, with Æther Bottle £3 10 0

For practical utility and convenience in use the Wet and Dry Bulb Hygrometer is vastly superior to all others. The engravings, Nos. 57 to 62, will show the various forms of Negretti and Zambra's Hygrometers from the simplest to the Standard instruments as manufactured by Negretti and Zambra for the various Scientific Observatories and Societies, the Government Meteorological Stations, the Metropolitan and County Hospitals, &c., &c. Most of these Hygrometers have Negretti and Zambra's Patent Procelain Scales and Enamelled Tubes.

68. **Wet and Dry Bulb Hygrometer,** simple form, on a stand (fig. 57) for table or shelf. *Price*, 12s. 6d., 16s., and £1 1 0

69. **Ditto Ditto Ditto** plain, portable, brass stand and metal cover (fig. 59). *Price*, £1 10 0

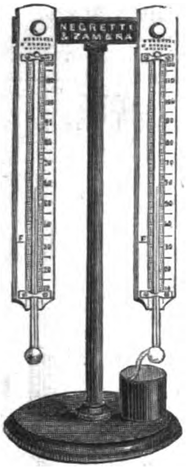


FIG. 57.

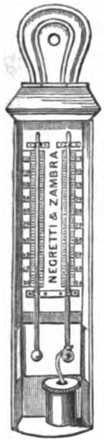


FIG. 58.

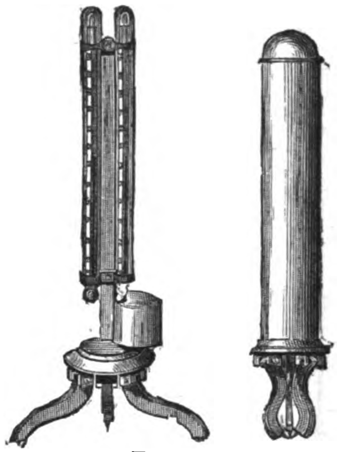


FIG. 60.

70. **Wet and Dry Bulb Hygrometer** with Wood or Zinc Scales, mounted on a Japanned Metal Case, suited for out-door use, the Greenhouse or Conservatory (fig. 58). *Price*, £0 14 0

71. * **Ditto Ditto** with Negretti and Zambra's Patent Porcelain Scale, in Japanned Case, as fig. 58. *Price*, £1 1 0

72. **Mason's Hygrometer**, portable brass-jointed tripod-stand and metal cover (fig. 60). *Price*, £3 3 0

73. **Negretti and Zambra's Standard Dry and Wet Bulb Hygrometer, or Psychrometer** (fig. 62), consists of two parallel thermometers, as nearly identical as possible, mounted on a wooden bracket, one marked *dry*, the other *wet*. The bulb of the wet thermometer is covered with thin muslin and round the neck of the stem is twisted or tied, as seen in fig. 62*, conducting-threads of lamp-wick, or common darning-cotton, these pass down into a vessel of water, placed at such a distance as to allow a length of conducting-thread, of about three inches; the cup or glass being placed on one side, and a little beneath, so that the water within may not affect the reading of the *Dry Bulb Thermometer*. In observing, the eye should be placed on a level with the top of the mercury in the tube, and the observer should refrain from breathing whilst taking an observation. The temperature of the air and of evaporation is given by the readings of the *two thermometers*, from which can be calculated the dew point, Tables being furnished for that purpose with the instrument.

The *dry* bulb thermometer indicates the temperature of the air itself; while the *wet* bulb, cooled by evaporation, shows a lower temperature according to the amount of and rapidity of evaporation.

This instrument is used by the members of the British Meteorological Society, and supplied to them by Negretti and Zambra. *Price* . £2 2 0

Glaisher's Tables for ditto 0 2 6

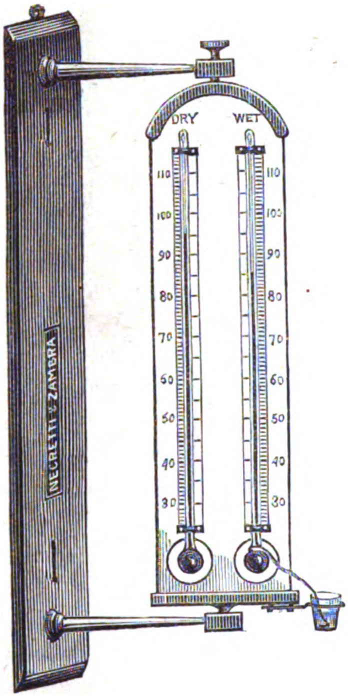


FIG. 61.

FIG. 62*.

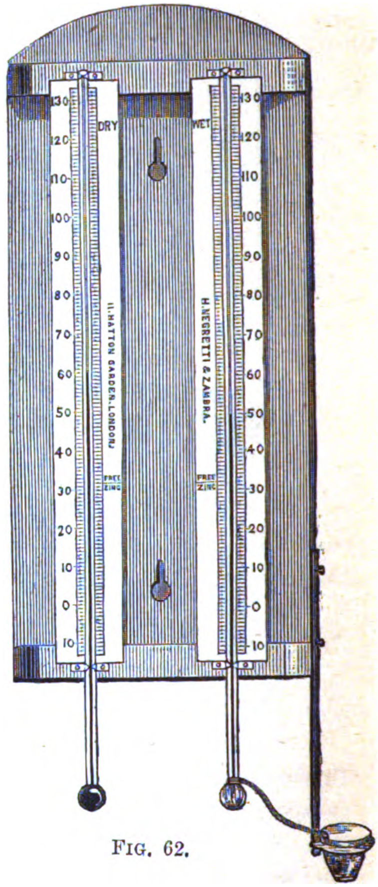


FIG. 62.

74. **Wet and Dry Bulb Hygrometer** for external Window use, with engraved Opal Glass or Porcelain Scale, mounted on a substantial and ornamental wood and metal Bracket, fitted with a clamping screw for setting the scale at any convenient angle for observation, as fig. 61.

Price, £2 10 0 and £3 3 0

75. **Portable Wet and Dry Bulb Hygrometer.** (fig. 63.) A most compact and convenient form of Hygrometer, invented by Negretti and Zambra, as a companion instrument to their Small Patent Maximum and Minimum Registering Thermometers and Pocket Aneroid Barometer (figs. 23 and 45), pages 20 and 42. The Hygrometer, with stand and water cistern, is fitted into a neat mahogany box.

Price . . . £2 2 0

Larger Standard size . . 3 3 0

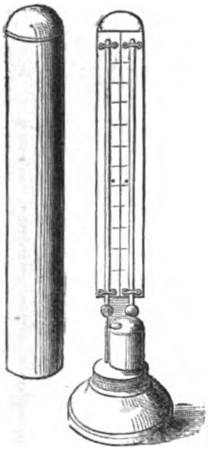


FIG. 59.

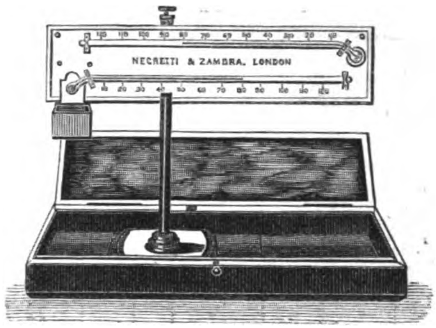


FIG. 63.

76. **Dine's Hygrometer.** We notice this apparatus chiefly as a matter of record. It is fully described along with an account of some remarkable results obtained from its use by its inventor, George Dines, Esq., in the Journal of the Meteorological Society; but, like Daniell's, Regnault's, and Jones's Hygrometers, it is not self-acting, and not so simple in its use as the Wet and Dry Bulb Instrument. Therefore, this Apparatus will only be supplied to order.

Price, £2 12 6 to £3 3 0

77. **Registering Hygrometer,** constructed with Negretti and Zambra's Patent Maximum and Minimum Registering Thermometers, each fitted up as a wet-bulb thermometer, to record the highest and lowest temperature of evaporation during any interval of time. *Price,* £3 3 0

79. **Hygrometer Screen.** The engraving (fig. 64), page 55, shews one of the best methods of fixing up and protecting the Hygrometer, the louvre boarded case affording free passage to the air and at the same time protection from rain, snow, the sun's rays or radiated heat from surrounding bodies. This Screen should be fixed at about four feet from the ground, the door facing due North. If fixed against a wall, there should be left a space between the back of the Screen and the wall, at least three or four inches, to insure a free circulation of air. It need hardly be pointed out that the Screen must be securely fastened to its support, wherever used, to prevent vibration or injury from wind. This arrangement is specially recommended by the Board of Trade for Marine Service both for Hygrometers and Thermometers.

Price, £1 0 0, or made to Order.

From the readings of the two thermometers, the dew-point can be deduced by formulæ (that know as Apjohn's is considered the most theoretically true), or from the valuable Hygrometric Tables by J. Glaisher, Esq., F.R.S.

78. For practical purposes in estimating the comparative humidity, the annexed table, on page 54, which is a reduction from Mr. Glaisher's elaborate work, will be sufficient.

Temperature by the Dry Bulb Thermometer.	Difference between Dry-Bulb and Wet-Bulb Readings.					
	2°	4°	6°	8°	10°	12°
	Degree of Humidity.					
34°	79	63	50	—	—	—
36	82	66	53	—	—	—
38	83	68	56	45	—	—
40	84	70	58	47	—	—
42	84	71	59	49	—	—
44	85	72	60	50	—	—
46	86	73	61	51	—	—
48	86	73	62	52	44	—
50	86	74	63	53	45	—
52	86	74	64	54	46	—
54	86	74	64	55	47	—
56	87	75	65	56	48	—
58	87	76	66	57	49	—
60	88	76	66	58	50	43
62	88	77	67	58	50	44
64	88	77	67	59	51	45
66	88	78	68	60	52	45
68	88	78	68	60	52	46
70	88	78	69	61	53	47
72	89	79	69	61	54	48
74	89	79	70	62	55	48
76	89	79	71	63	55	49
78	89	79	71	63	56	50
80	90	80	71	63	56	50
82	90	80	72	64	57	51
84	90	80	72	64	57	51
86	90	80	72	64	58	52

The total quantity of aqueous vapour which at any temperature can be diffused in the air being represented by 100, the per-centage of vapour actually present will be found in the table opposite the temperature of the dry bulb thermometer, and under the difference between the dry-bulb and wet bulb temperatures. The degree of humidity for intermediate temperatures and differences to those given in the table can be easily estimated sufficiently accurately for most practical purposes.*

This table will be found serviceable to horticulturists, since it will enable them to estimate the chilling effect of dew or hoar-frost on tender plants.

In England the usual difference between the thermometer readings,—in the open air, shaded from the sun, reflected heat, and currents of air,—ranges from one to twelve degrees. In hot and dry climates, as India and Australia, the range out of doors has been found as much as 30°.

* A still more comprehensive but simple Dew-Point or Humidity Table has been recently published by William Marriott, Esq., F.M.S., price 6d.

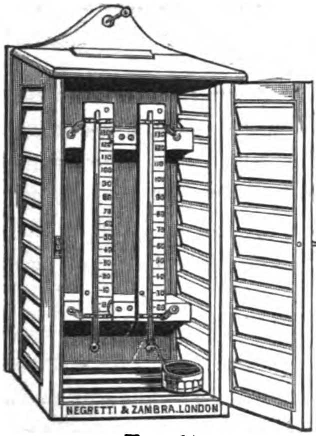


FIG. 64.

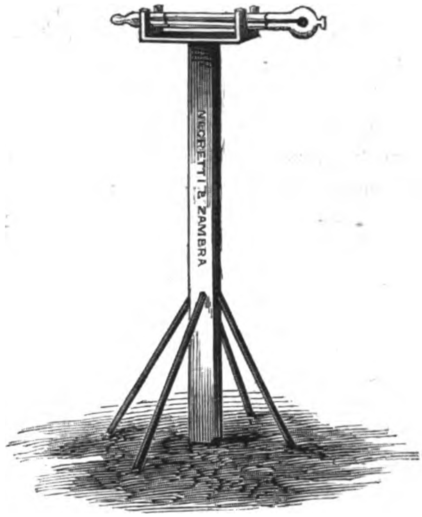


FIG. 65.*

The Summer and Autumn of the year 1859 were specially remarkable for a most unusual Thermometric and Hygrometric condition of atmosphere, and Londoners will long remember the state of the River Thames during that period. Deficiency of water supply during 1858 and 1859, and great evaporation (often to *fourteen* degrees of thermometrical difference in Mason's hygrometer), caused a condition of its stream excessively offensive, if not actually pestilential and unhealthy. Everywhere a want of water was felt, and this had been of considerable duration. In August the heat reached 92° (in places where usually summer heat is not above 80°), and the temperature of evaporation was 78°, by the same hygrometer.

INSTRUCTIONS FOR THE USE OF THE WET AND DRY BULB HYGROMETER.

78. The muslin on the bulb of the Hygrometer should be washed occasionally by pouring water over the bulb; and it should be replaced by a fresh piece at least once a month. Accuracy depends very much upon keeping the wet bulb clean, free from dust, and *not too* wet.

When the wet bulb is frozen, some cold water should be taken from under ice, being cautious to raise its temperature as little as possible, and the thermometer bulb should be wetted with it by means of a camel-hair brush or feather. After waiting a few minutes, the temperature of evaporation may be observed. The water should be either distilled or rain water, or if this be not procurable, the softest pure water which can be had. The water vessel

* Fig. 65. See ante page 36.

should be replenished *after*, or some little time *before*, observing; because observations are incorrect if made while the water is either colder or warmer than the air.

In connection with the barometer, the Wet and Dry Bulb hygrometer is very useful, not only on land, but especially at sea, where other kinds of hygrometers cannot be practically used. A fall in the barometer is indicative of coming wind or rain: if the hygrometer shows increasing dampness by the difference of the readings becoming smaller,—rain may be anticipated. On the contrary, if the hygrometer shows continuing or increasing dryness, a stronger wind is probable, without rain.

The Hygrometer is eminently useful in regulating the moisture of the air of apartments; a difference in the thermometer readings of from 5° to 8° being considered healthy. Many diseases require that the temperature and humidity of the air which the invalid breathes should be very carefully regulated. In a room, the hygrometer should be placed away from the fire, but not exposed to draughts of air.

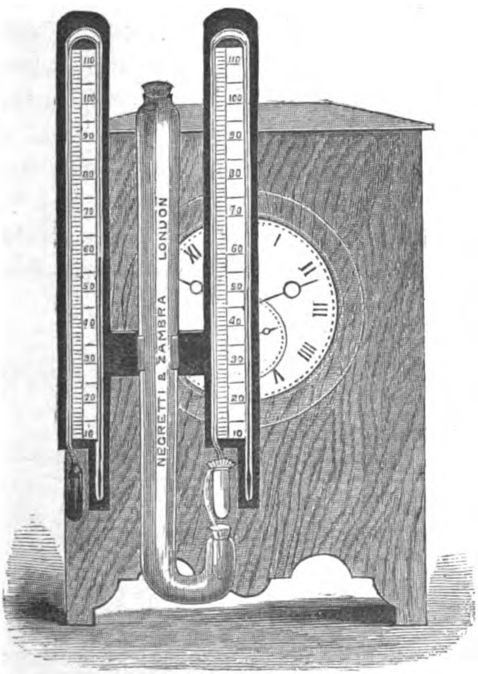


FIG. 65.†

Negretti and Zambra's Self-Recording Hygrometer, fig. 65.† The Thermometers in this Hygrometer are similar to those used in Negretti and Zambra's Patent Recording Deep Sea Apparatus. It will be seen by our woodcut that the two Thermometers described in another section—Recording Thermometers—with the Water Cistern are mounted upon a frame in connection with the clock. An index hand on the dial of the clock enables the observer to arrange the release of a catch or detent at any desired moment, and by the action of the clock cause the frame with the Hygrometer to revolve on its axis. By this movement the mercury contained in the left hand tubes of the Thermometers breaks off at the point marked D, and passes over into the right hand tubes, where it records the temperature existing at any time the clock is arranged to turn over the Hygrometer similar to our Recording Thermometer.

Price, £6 6 0

RAIN GAUGES.

It is hardly possibly to over-estimate the value and importance of carefully compiled statistics of the Rainfall.

The two great sanitary questions of the day, viz., the Water supply and Sewage of large towns are in a very great measure connected with the amount of rain falling during a given period, and reliable particulars of the rainfall are specially valuable both to the Civil and Hydraulic Engineer.

The Farmer and commercial Financier are also both deeply interested in the results of a probable dry or wet season influencing the growth, amount, and value of various crops and produce of the earth. We subjoin a few facts we think may prove useful and interesting.

Fall of Rain at the Royal Observatory, Greenwich.

Taking December, January, and February as the winter months; March, April, and May as the spring months; June, July, and August as the summer months; September, October, and November as the autumn months, the quantities which fell in the different seasons were as follows :—

—	1842.	1843.	1844.	1845.	1846.	1847.	Mean.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Winter .	2·81	4·14	5·16	5·33	5·42	4·77	4·60
Spring .	4·42	5·98	3·59	4·27	5·43	3·16	4·47
Summer .	5·69	7·34	6·63	6·84	6·00	4·12	6·10
Autumn .	9·65	7·01	9·58	5·90	8·44	5·56	7·69
Total .	22·57	24·47	24·96	22·34	25·29	17·61	22·86

The quantity of rain which fell at the Royal Engineers' stations during the year 1853-4, was as follows :—

	Inches.		Inches.
Edinburgh	23·15	Barbadoes	68·24
Guernsey	32·77	Ceylon	71·63
St. John's	55·05	Mauritius	39·52
Gibraltar	47·29	Fremantle	33·94
Malta	28·08	New Zealand	48·42
Jamaica	34.31		

The district of Cutch, at the mouth of the Indus, is all but a rainless district, but in the Khassya hills, north of Calcutta, the annual fall amounts to 600 inches or 50 feet, eleven-twelfths of which descend in the six rainy months, the heaviest known annual rainfall in the world; Professor Oldham measured a fall of 25·5 inches in one day.

Tropical countries have a dry and a wet season during the year: *dry*, when the sun is at the opposite side of the equator; *wet*, when the sun is overhead. With reference to the British Isles, the statistics collected by Mr. G. J. Symons indicate that, the stations of least rain are inland, or on the east or south-east coasts; the stations of greatest rain are on the western coasts. The rainfall is very large in the vicinity of mountain chains or groups, unless the station happens to be some miles to the north-eastward.

Lincoln is the dryest recorded station in England, the mean annual rainfall being 20 inches. The wettest recorded station is Stye, at the head of Borrowdale in Cumberland, where the mean annual rainfall amounts to 165 inches.

A fall of rain measuring a tenth of an inch in depth is equal to a deposit of about forty hogsheads per acre.

The following will most concisely illustrate our subject.

"RAINFALL, AND ITS RELATION TO CIVILISED LIFE.

"At the meeting of the Institution of Surveyors, February 13th, 1877, Mr. G. J. Symons read a paper upon the above subject. The author commenced by stating that he proposed to show in how many ways a knowledge of the rainfall, or of the quantity of water naturally precipitated over any given locality, was of importance to every civilised being. Having given sketches of the mode of measuring rainfall, and the rules to be observed in doing so, the lecturer went on to say that measurements were now made daily at 1,500 stations in the United Kingdom, and at longer intervals at about 800 others. Taking the country generally, July and October might be regarded as the *wettest months*—July owing to the very large amounts often falling during thunder-storms, and October from frequent steady rains; while the *least fall happens* in April and May. After touching on some heavy rainfalls that had occurred at various places the paper proceeded to deal with the water supply of towns, which claimed consideration respecting the practical application of rainfall statistics. *Every inch of rain gave* 22,623 *gallons of water per acre, or* 14½ *million gallons per square mile, and this fact formed the basis of all calculations respecting water supply.* Of the entire quantity of rain falling in any given locality some was evaporated, some flowed off the surface, and some percolated to feed the subterranean springs, though the proportion varied with districts and in different years. The rough rule which had been frequently acted upon with reference to large schemes of water supply was that out of a fall of 40 inches 6.6 inches were deducted for floods and unstorable water and 12 inches for evaporation and percolation, leaving the available rainfall 21·4 inches. After giving estimates of the amount of rain that can be gathered on roofs of mansions for use, the lecturer went on to deal with the rainfall and crops. While recognising that agricultural drainage had added millions to the productive power of the country, he thought that in many districts it had been carried to too great an extent, especially in the undulating districts of the midland counties, where drainage had hurried the rain into the rivers, temporary floods were followed by half-empty streams, and a

few weeks' dry weather left but a few pools of stagnant, unwholesome water. The relation of rainfall and drainage to the effect of manure had not been sufficiently considered, as on a heavily manured and thoroughly drained field a heavy rainfall washed the manure into the streams, and, instead of fertilising the crops, contaminated the water supply. These two aspects of the great question of agricultural drainage afforded strong confirmatory evidence in favour of the argument that when man tried to alter natural conditions he must look far ahead or he might find he had incurred one evil through clumsily trying to cure another."

POSITION FOR RAIN GAUGES.

79. From the observations made at the Royal Observatory at Greenwich, the fact is clearly established that in the lower regions of the atmosphere, the quantity of rain which falls diminishes with the altitude above the ground.

The height for placing the receiving surface of a rain gauge is somewhat open to a difference of opinion. Mr. Glaisher's gauge is directed to be "half sunk in the ground." This would place the edge of the gauge at about 8 inches from the surface of the ground. Mr. Symons gives 12 inches as most correct, 10 inches as a mean between these will be perhaps the best to adopt. Rain gauges should be placed on a level piece of ground, and not on a slope or terrace, away from walls or trees, as many feet from their base as their height, the edge of the funnel should be set quite level. Unless for special observations Rain Gauges should not be placed on roofs or any very elevated position. It is very important that Rain gauges be occasionally examined to see that the Receiving Funnel be not choked up by dust or leaves, and that at very wet stations the receiving portion of this Gauge be sufficiently large to hold any possible rainfall;—even the probable occurrence of a water-spout might be provided for in hilly or very exposed situations. Gauges should be well supported to prevent their being knocked down or blown over by the wind, and after snow or frost the gauges should be placed in a warm room until the collected contents are melted and can be measured. In measuring off the quantity of collected rain, the graduated glass should be held quite upright, and the reading taken midway between the two apparent surfaces of the water. The rain should never be collected in the graduated measure, especially in winter, to avoid risk of breakage by frost.

79* **Measurement of Rain.** The Rain Gauge should be examined every day, at nine a.m., and the amount of water collected by it entered in the register, as having fallen on the previous day; for if we measure at nine, a.m., to-day, it is probable, under ordinary conditions, that more of the Rain collected by the Gauge will have fallen during the fifteen hours of the previous day up to midnight than during the nine hours extending from midnight to nine o'clock of the following morning.

A vast amount of interesting and most valuable information respecting Rain Gauges and the Rainfall will be found in Negretti and Zambra's *Treatise on Meteorological Instruments*, and Mr. G. J. Symons' eminently useful publications as enumerated in our list of books at the end of this section.

INSTRUMENTS USED FOR MEASURING THE RAINFALL.

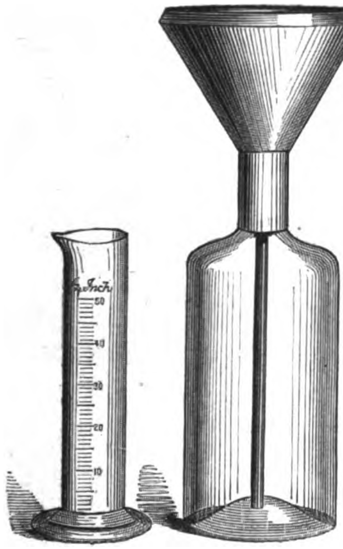


FIG. 66.

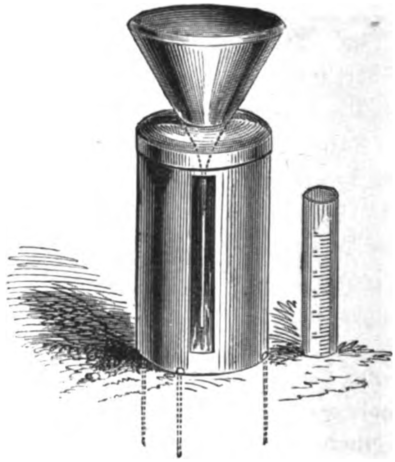


FIG. 67.

80. **Howard's Rain Gauge,*** (fig. 66). The simplest form of the instrument constructed and used by the celebrated meteorological writer, Luke Howard, from whom it derives its name; it has a 5-inch Copper Funnel, with a turned brass Rim, fitted to a stoneware or glass bottle, with a glass graduated measure divided to hundredths of an inch. *Price* £0 10 6

81. **Symons' Rain Gauge,** (fig. 67), is an improvement on the above instrument, the glass receiving bottle being enclosed and protected by a metal case, with openings at the side for the convenience of observing approximately the collected rainfall without disturbing the frame, which is firmly supported in the ground by strong spikes. The measure holds half an inch of rain for a 5-inch area subdivided into hundredths. Mr. Symons has recently made some alterations in the arrangement of his gauge; these we shall describe on another page. *Price* . . £0 10 6

Ditto, in copper . 0 15 0

82. **Glaisher's Rain Gauge,** (fig. 68).—This gauge is eight inches diameter, and arranged for the reception of the water only which falls upon its receiving surface, and for the prevention of loss by evaporation. The rain is first collected in a funnel, the receiving surface of which is accurately

* Pulviometer, Ombrometer, Udometre.

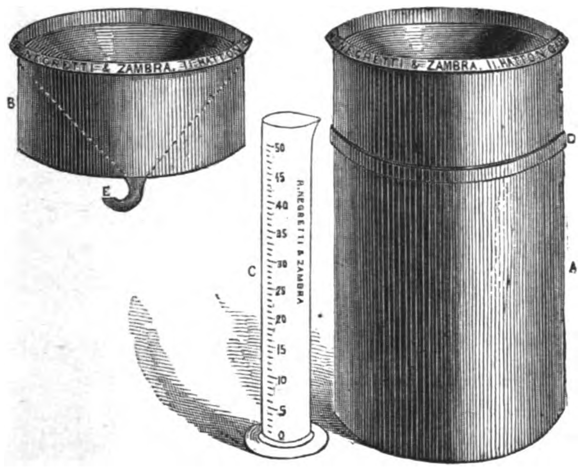


FIG. 68.

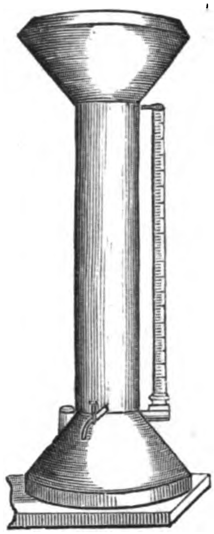


FIG. 69.

turned in a lathe, and terminated at its lower extremity in a bent tube of small aperture in which the last few drops of rain remain as shewn in the engraving. The glass receiving vessel is graduated to hundredths of inches according to the calculated weight of water, as determined by the area of the receiving surface. In use, the gauge is partly sunk below the surface of the soil, so that the receiving surface is about eight inches above it. Thus situated, no water escapes by evaporation in any month of the year. If placed differently, the readings must be taken daily.

Price, in jappened tin . £1 1 0
in copper . . 1 10 0

RECEIVING VESSEL FOR GLAISHER'S GAUGE.—*Price*, in japanned tin or copper, 2s. & 3s. 6d.

As some meteorologists have objected that the curved tube at the base of the funnel is liable to be choked up with dust, Messrs. Negretti and Zambra, if desired, supply these Rain Gauges with a straight tube of sufficient length to reach very nearly the bottom of the receiving vessel, thus obviating this difficulty, and at the same time preventing evaporation.

83. **Glaisher's Rain Gauge**, with extra large receiving vessel, mounted with a convenient tap for drawing off the water, suited for Tropical countries or stations where there is an excessive rainfall. *Price*, in copper, £3 3 0

The 8-inch Glaisher's Rain Gauges are now considered by scientific men the best, and consequently are almost universally adopted as Standard instruments, but at the same time we would observe that very valuable results have been obtained by the use of Mr. Symons' 5-inch gauge in many parts of the United Kingdom.

84. **Rain Gauge** (fig. 69), having a receiving surface of 12 inches diameter, and graduated glass tube divided to inches, tenths, and hundredths of an inch, showing by simple inspection, without the use of a graduated measure, the amount of rain fallen. In japanned metal, with tap for emptying the gauge.

Price . . . £2 10 0
Ditto, ditto, in copper . 3 10 0

85. **Rain Gauge**, a similar but rougher form of No. 84, without brass mountings, and instead of the graduated glass tube, it is fitted with a boxwood scale, attached to a metal float inside the gauge, on which can be read off, by simple inspection, the amount of rain fallen. *Price*, complete, £2 2 0

The **Rain Gauges**, (Nos. 84 and 85), are not suitable for measuring small quantities, but are useful where the rainfall is excessive.

86. **Admiral FitzRoy's Rain Gauge**, with graduated glass dipping tube steadying rods or supports, and frame, now very rarely used.

Price, in stout copper £3 3 0

87. **Pocket Rain Gauges**, with 3-inch receiving surface and corresponding measuring glasses have been made by Messrs. Negretti and Zambra but they cannot be recommended.

88. **Square Rain Gauge**, having a receiving surface of 10 inches by 10 inches, and about 12 inches in height made of stout copper—with a graduated glass measure divided into one hundredths of an inch as described in Col. Sir H. James's instructions for taking meteorological observations for the use of the Royal Engineers, this Gauge is shown partly in section. (fig. 71).

Price £2 10 0

89. **Meteorological Office Rain Gauge.** Our woodcut (fig. 70) shows a recent form of 8-inch Rain Gauge introduced and recommended by the London Meteorological Office. It will been seen that essentially this form of gauge is the same as Glaisher's but with an additional vertical cylinder about 6 inches above the funnel—its use is to prevent in splashing and also most especially to collect and measure snow. *Price*, in japanned metal . £2 2 0
Ditto in copper . . . 2 15 0

90. **The Snowdon Rain Gauge.** When describing Rain Gauge No. 81, we mention that Mr. Symons has made some alterations in the arrangement of his Gauge—these are chiefly the addition of a vertical cylinder above the funnel and doing away with the openings in the external case enclosing the receiving bottle; also Mr. S. advises that the gauge be almost entirely plunged below the surface of the earth as a protection from evaporation by heat, and breakage by frost—another advantage of the close cylinder is that should the collecting bottle be broken by frost or otherwise its contents will be saved to the observer. The form of this Gauge is that of the one previously described (fig. 70) with a collecting funnel and cylinder of 5 inches diameter. This instrument is named by Mr. Symons the Snowdon Rain Gauge.

Price, complete in japanned metal . £0 17 6
Ditto, ditto in copper . . . 1 1 0

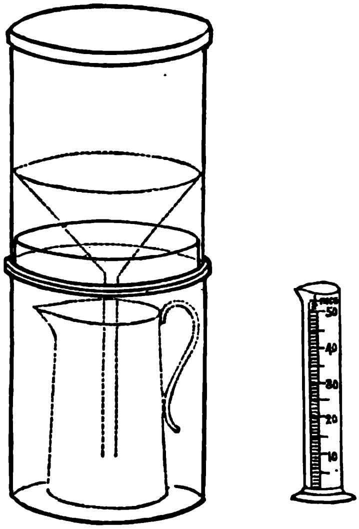


FIG. 70.

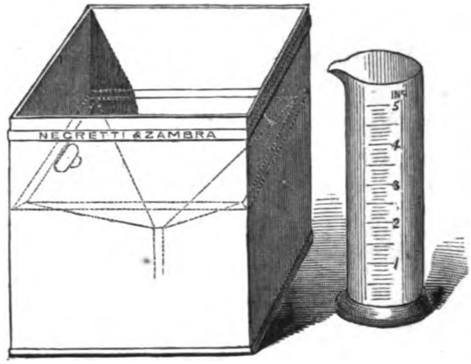


FIG. 71.

91. **Negretti and Zambra's Tropical Rain Gauge,** similar in form to No. 70, but of extra large size, to hold 50 inches of rain, with a metal tap for drawing off the collected water.

Price, complete with receiving vessel and graduated measuring jar in japanned metal £2 10 0
Ditto Ditto in Stout Copper 3 5 0

92. **Crossley's Registering Rain Gauge** (fig. 72) is a 10-inch square gauge, the receiving area being equal to 100 superficial inches. The water collected by the funnel passes down a tube to a vibrating bucket connected with and giving movement to a train of wheels communicating with three dials recording the amount of rain passing through the gauge, in inches, tenths, and hundredths. The mechanism is simple, and if occasionally examined and kept clean it will give a faithful record to $\frac{1}{20}$th of an inch depth of rain. A small test measure, holding 5 cubic inches of water, is sent with each instrument for the purpose of testing and correcting the gauge, and full printed instructions for fixing, reading off the dials, &c., &c., accompany each instrument. Under careful management this registering gauge will be found very useful. *Price,* £4 12 0

Great care should be taken to prevent the edge of the collecting or receiving funnels of Rain Gauges being bent or dented, for should the area be not a true circle the full amount of rain will not be collected. Circular Rain Gauges are preferred to Square ones the latter being more liable to get out of shape than the former.

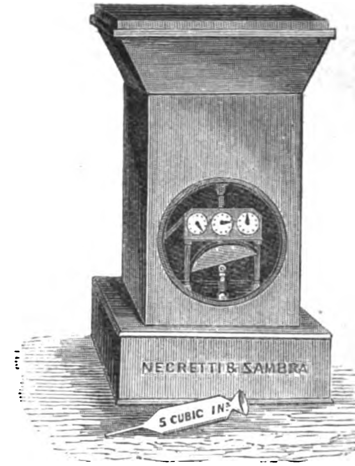


FIG. 72.

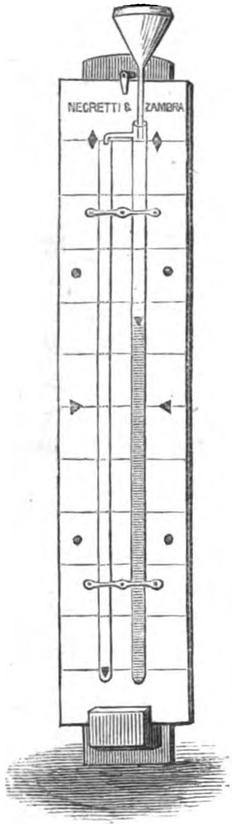


FIG. 73.

93. **Symon's Storm Rain Gauge,** (fig. 73). This instrument the inventor states he constructed, not as a standard or thoroughly accurate instrument, but as very convenient for observing the rate of rainfall minute by minute without either measuring or going out of doors.

The area of the funnel as compared with that of the glass tube is so large that an inch of rain is about 2 feet long on the tube, therefore, as each tenth of an inch is about 3 inches long, the water can be seen gradually rising in the tube as the rain continues and the quantity in any interval, however short, may be easily noted. In order to facilitate reading at a distance floats are placed in each tube, and these being white while the board is black are clearly visible at a great distance. Each division on the scale is a tenth of an inch, and it will be seen that the first being filled up to the top line (*i.e.*, ten tenths, or one inch) the rain flows into the second and that float begins to rise until two inches of rain have fallen.

The Gauge is emptied by turning the button (A) and then inverting the Gauge, the floats cannot fall out. In frosty weather it is advisable to empty out all water from the Gauge and place a cover over the collecting funnel.

Symon's Storm Rain Gauge will be made to order.

A larger form of Registering Rain Gauge (Pluviograph) will be described in connection with Osler's Anemometer.

94. The measurement of Snow or Hail is to be effected by thawing the quantity collected in the funnel of the rain gauge, and measuring the water resulting therefrom. The rain gauge recommended by the Meteorological Office (No. 89), is specially contrived and adapted for this purpose, the snow or hail collected being thawed by a known quantity of hot water. This quantity

being subtracted from resulting amount of water, will give the value of the collected snow or hail.

"It is generally stated that a foot of snow gives an inch of water; so that one-twelfth of the depth of the snow in inches would be the amount of rain corresponding to a given fall of snow. This estimate is, however, only a very loose approximation, as the layer of snow is not always of uniform density."

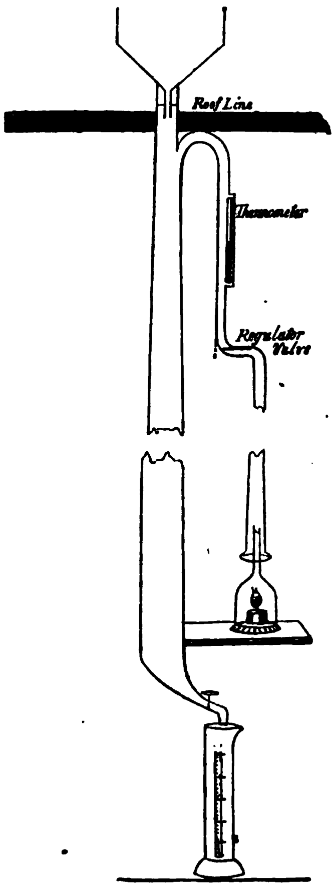


FIG. 74.

95. **Bentley's Snow-Melting Rain Gauge.** (fig. 74.) A difficulty has hitherto existed in the exact admeasurement of rainfall—viz., the necessity of leaving snow, sleet, or hail, whenever they occur, in the Gauge until they can be melted. The ordinary Gauges not being always capable of containing the amount of a long-continued fall of snow.

This apparatus is of simple construction, contrived by Mr. R. Bentley, at Upton (near Windsor), for use in connection with an 8-inch Guage situated on a roof inaccessible under ordinary circumstances. On reference to the accompanying diagram, it will be seen that the distinguishing feature of this Gauge *is the melting of any snow or sleet immediately on its reception.* This arrangement makes it very useful in connection with any automatic registering apparatus, or where the Gauge, from its position, is not easily accessible, and at night.

The action of the Gauge is briefly thus: The rain or snow fall is received in the usual 8-inch funnel, from the bottom of which it falls by gravity to the end of the tube (of whatever length that may be) *without touching the sides.* This is a very important point, and is gained by fitting a short guide-pipe, of some six inches in length to the bottom of the funnel, and by the internal diameter of the long tube being gradually slightly increased in proportion to the length of the tube. At the bottom of the tube (which is within the house) is placed a tap and measuring-glass. If preferred, the tap can be left open or removed, and an automatic recording apparatus substituted.

By the side of the main tube, but sufficiently distant from it for any heat not to be conveyed sideways, is the melting tube. The hot air is furnished by a gas jet or lamp—or even a candle or night-light—and being regulated to a

temperature of from about 40° to 46° Fahrenheit, by the thermometer enclosed in the tube (and exposed to view by means of a piece of glass inlet), ascends through the funnel, and gradually melts the snow, etc., as it falls in. Too high a temperature should not be employed, as being conducive to evaporation.

An additional protection may also be afforded by the employment of a self-acting valve midway in the heating tube, to expand with any access of heat, in so doing partly to close the way, and at the same time to push open a small trap-door, letting out some of the hot air and admitting some cooler air from the outside. As soon as the proper temperature has been by this means restored, the valve would contract into its normal position. This arrangement, however, owing to the delicacy of the adjustment, is very apt to get out of order.

Messrs. Negretti and Zambra construct the above apparatus to order; but no exact prices can be quoted as the cost would vary greatly according to the extent and nature of the work and the position in which it is to be placed.

A small piece of very open wire-work might be placed across the receiver, *half way down*, in case of leaves, &c., falling in. In the construction of the Gauge, copper should be employed.

95.* **Marine Rain Gauges.** Negretti and Zambra have constructed several different forms of Rain Gauge for use on board of ship. One arrangement having gimbal mountings similar to a steering compass has been found the best, but the records obtained by their use at sea have been unsatisfactory and not considered of any scientific value.

EVAPORATION.

96. Mr. R. H. Scott, of the Meteorological Office, writing on this subject remarks, that it "is one of very great importance, especially as regards its connection with Rainfall and Water supply, and well deserves especial attention; but it cannot as yet be said that the results hitherto obtained merit much confidence as regards their applicability to the evaporation occurring in nature, owing to the exceptional manner in which the observations have been made."

Atmometers of many forms have been invented and constructed, both in this country and on the Continent, but, at present, nothing satisfactory has been devised; hence the difficulty of making any very accurate observations in connection with evaporation from the surface of water.

96.* **Evaporation Gauge** (fig. 75), (Evaporometer), for showing the amount of evaporation from the earth's surface. This gauge consists of a brass vessel, of eight inches diameter, corresponding with Glaisher's Gauge, the area or evaporating surface of which is accurately determined; and also a glass cylindrical measure, graduated into inches, tenths, and hundredths of inches. In use, the Evaporating Gauge is nearly filled with water, the quantity having been previously measured by means of the glass cylinder; it is then placed out

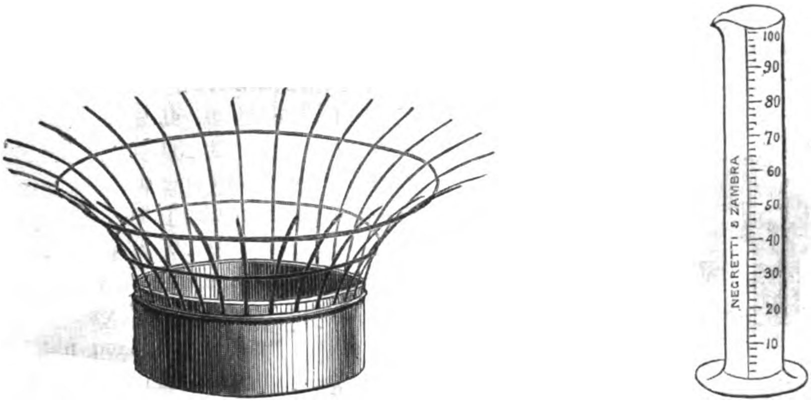


FIG. 75.

of doors, freely exposed to the action of the atmosphere; after exposure, the water is again measured, and the difference between the first and second measurement shows the amount of evaporation that has taken place. If rain has fallen during the exposure of the evaporating dish, the quantity collected by a rain gauge must be deducted from the amount of the measured contents of the evaporating dish when the observation is made. The wire cage round the gauge is to prevent animals, birds, &c., from drinking the water.

Price, with graduated measure . . . £1 3 6

97. **Atmidometer*** (Dr. Babington's), for measuring the evaporation from water, *ice* or *snow*. Consists of an oblong hollow bulb of glass or copper, beneath which, and communicating with it by a contracted neck, is a second globular bulb, duly weighted with mercury or shot. The upper bulb is surmounted by a small glass or metal stem, having a scale graduated to grains and half-grains; on the top of which is fixed horizontally a shallow metal pan. The bulbs are immersed in a vessel of water having a circular hole in the cover through which the stem rises. Distilled water is then gradually poured into the pan above, until the zero of the stem sinks to a level with the cover of the vessel. Thus adjusted, as the water in the pan evaporates, the stem ascends, and the amount of evaporation is indicated in grains. This instrument affords a means of measuring evaporation from *ice or snow*. An adjustment for temperature is necessary. *Price*, £3 3 0

98. **Glaisher's Thermometer Stand** (fig. 76).—The Thermometer Stand consists of a horizontal board as a base, of a vertical board projecting upwards from one edge of the horizontal board, and of two parallel inclined boards, separated from each other by blocks of three inches in thickness, connected at the top with the vertical board, and at the bottom with the horizontal board,

* Mr. Scott suggests that Leslie's term Atmidometer is more classically correct, but that Atmometer has the advantage of being shorter, without being absolutely incorrect.

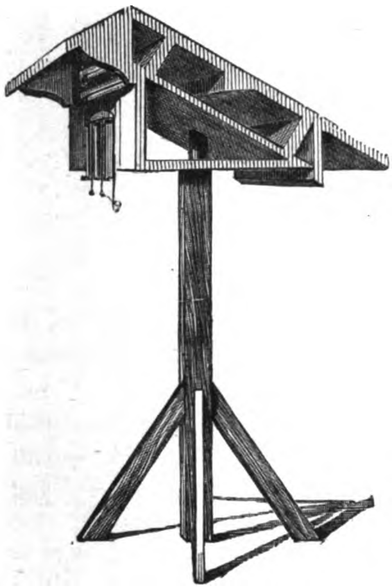


FIG. 76.

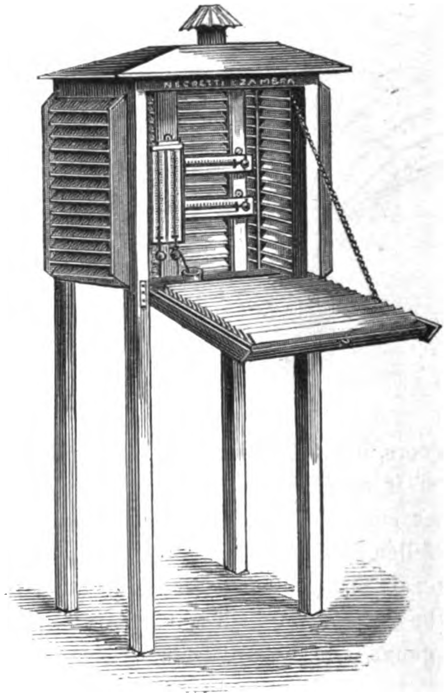


FIG. 77.

and the air passes freely about and between all these boards; on the top of the inclined boards is a small projecting roof to prevent as much as possible, the rain or snow falling on the bulbs of the instruments which are mounted on the front of the vertical board. The bulbs of the Thermometers, &c., all project below the edge of the vertical board, in order that the air may pass freely over them from all directions. The whole frame is constructed to revolve on an upright post firmly fixed to the ground, as shown in the engraving; and in use, the inclined side should be always turned towards the sun.

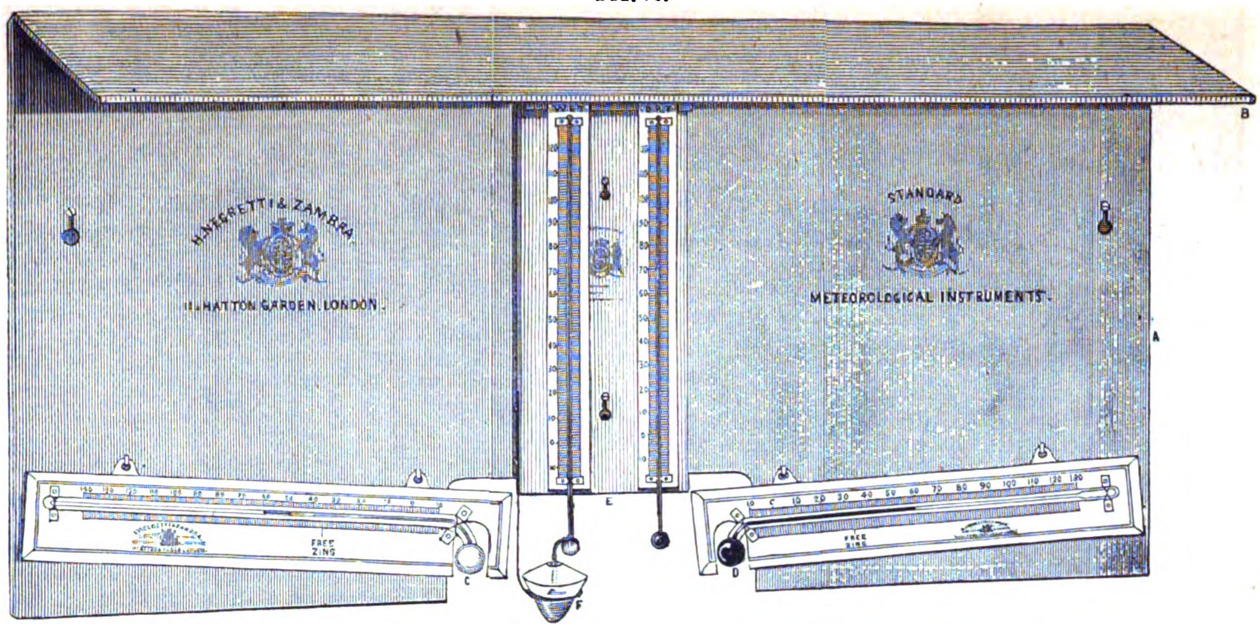
Price, . . . £3 3 0

99. **Stevenson's Thermometer Screen**, shown in fig. 77. The louvres in this arrangement are double, sloping in opposite directions, so that whilst there is free access of air to the interior, the radiant heat and rain are excluded. This form of screen has been found to be the best of any yet invented, for climates similar to the British Islands; but is not suitable for climates subject to great extremes, such as India or Canada.

This Screen should stand on open ground and be strongly supported, not under the shadow of trees or houses, and at least twenty feet from any wall, and the floor of the screen to be about four feet above the ground. The door of the Screen should face due north. *Price* . . . £3 0 0

NEGRETTI AND ZAMBRA'S THERMOMETER AND HYGROMETER BOARD.

FIG. 78.



100. Figure 78 is a convenient arrangement for supporting Registering Thermometers, &c., for scientific observations. It has a projecting roof, *B*, to carry off rain from the instruments, the board, *A*, being erected vertically. The hygrometer is placed at *E*, with the water cup at *F*. The minimum registering thermometer is represented at *C*, in the position most favourable to its certain action; and at *D*, is shown Negretti and Zambra's Patent Maximum Registering Thermometer, the position of which may be more nearly horizontal than there exhibited, although a slight depression of the bulb-end of the frame is desirable, but not necessary, as this thermometer can be used in any position.

The best position for placing the Thermometer board is facing the North, at about five feet from the ground, supported firmly to prevent vibration from wind and away from all walls or trees, or if this board be supported from a wall it should be well blocked out from it at least 8 or 12 inches to allow a free current of air to circulate behind it. *Price*, £1 12 6

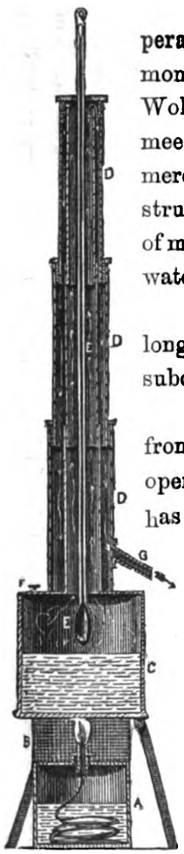


FIG. 79.

101. **Apparatus for Determining Elevations by the Temperature of the Boiling-point of Water.**—The Barometrical Thermometer, or Hypsometrical Apparatus, is an improved form of Wollaston's Apparatus constructed by Negretti and Zambra, to meet the requirements of travellers in circumstances where the mercurial barometer cannot be conveniently employed. The instrument is very portable, and affords a ready and accurate means of measuring heights by observations of the temperature of boiling water. The apparatus is shown in section (fig. 79). It consists,—

First,—of a very delicate thermometer, about 12 inches long, the scale ranging from 180° to 212°, having each degree subdivided so as to show distinctly 0° 1.

Secondly,—a metal boiler (C) mounted on a small tripod stand; from the boiler proceeds three double tubes (E E E) and (D D D), open at top; screwed on the top of the boiler; the outer tube has two openings, one at the top, through which the thermometer (E E) is inserted, passing down to within an inch of the water in the boiler, and supported by means of india-rubber washer, as shown in fig. 79; the second opening forming an outlet for the steam, as shown at (G). These double tubes are now constructed to separate at the joints by a simple slide fitting, so that any length of the Thermometer Stem can be made visible varying with the elevation at which the tubes are adjusted. The object of the double tube is to ensure a steady boiling-point, which it would be impossible to obtain in open air experiments, were only a single tube employed. (A) is a metallic spirit lamp, surrounded with wire gauze (B) to prevent the flame being extinguished when experimenting in the open air.* The whole instrument when packed in a leather case for travelling is shown in fig. 79*. Each instrument is furnished with a carefully computed set of tables, from

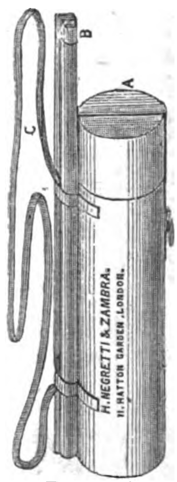


FIG. 79.*

* A Russian spirit furnace, surmounted by a small spirit lamp, is sometimes furnished. The object of the Russian furnace is to cause the water to boil rapidly; when that has been accomplished, the small lamp is lighted, and placed over the blast from the furnace, which it extinguishes, at the same time its flame is sufficient to keep the water boiling.

which may be obtained, by an easy calculation, the elevation corresponding to any observed boiling-point between the temperatures of 180° and 212°.

To use the Boiling Point Apparatus, it is simply necessary to pour into the boiler, through the small opening (F) on its surface, a sufficient quantity of water to fill it about one-third, and afterwards close it by means of the screw for that purpose; the lighted spirit lamp is then applied, and when the water is made to boil, the steam rises, surrounding the bulb and tube, and descending between the two tubes, issues from the opening at (G.) After a few seconds, the mercury in the thermometer will rise and become stationary; the degree indicated by it must then be noted, when, by reference to the tables, the elevation of the spot where the experiment has been performed may be obtained.

The temperature of the air should be observed by a reliable thermometer at the same time.

Price, with Spirit Lamp, in Sling Case,		£5	0	0
Extra Standard Thermometer	.	1	10	0
Extra Thermometer for Air Temperature	.	0	10	6

The following table expresses very nearly the elevation in feet corresponding to a fall of 18 in the temperature of boiling water:—

Boiling Temperatures between.	Elevation in Feet for each Degree.
214° and 210°—	520
210 and 200—	530
200 and 190	550
190 and 180	570

Rule for computing heights from observations with the Boiling Point Apparatus or Mountain Thermometer, by Negretti and Zambra's Boiling Point Tables.

From Table I. take out the heights in feet corresponding to the boiling-points observed at the upper and lower stations respectively. The difference between these two numbers, multiplied by the factor in Table III. for the mean temperature of the air, is the difference in height required.

EXAMPLE:

At upper station, boiling-point = 187°·3; temp. of air = 26°.
At lower station, boiling-point = 210°·4; temp. of air = 68°.
Boiling-point = 187°·3; height from Table I. = 13495 feet.
Boiling-point = 210°·4; height from Table I. = 905

Difference = 12590

Mean temp. of air = 47°; factor from Table III. 1·033.
Required difference between the two stations = 12590 × 1·033 = 13005 feet.

To determine a height with accuracy, it is necessary that pure water should be used, distilled water if possible, and a similar observation should be made at the same time at a lower station, not very remote laterally from the upper, and both should be many times repeated. When such observations have been very carefully conducted, the height of the upper station above the lower may be ascertained with great precision, as has been repeatedly verified by subsequent trigonometrical measurement of elevations so determined. If the lower station be at the sea-level, the absolute height of the upper is at once obtained.

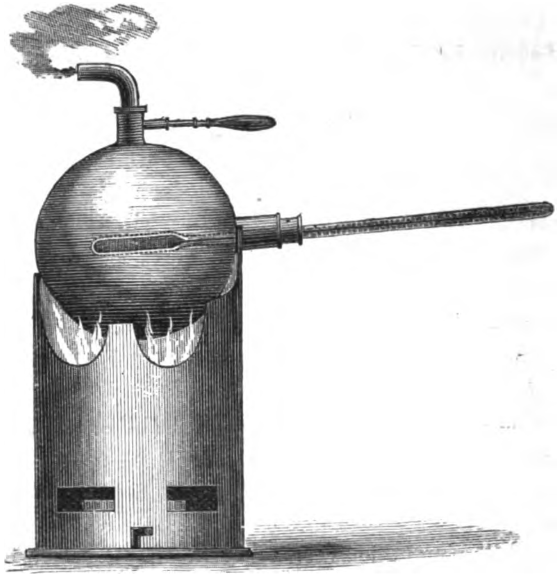


Fig. 80.

102. **Negretti and Zambra's New Pocket Boiling-Point Apparatus,** (fig. 80) consists of a small globular metal boiler, mounted upon a metal support or stand. In the base of this stand is formed a receptacle for holding and burning spirits of wine, by which water in the boiler is rapidly heated up to the boiling-point. On the top of the boiler is a tube for the escape of steam during the operation, and on one side is seen another tube (horizontal), into which is inserted one of Negretti and Zambra's Patent Maximum Registering Thermometers, very finely and carefully divided upon its stem, of sufficient range for all possible elevations to be ascertained by the boiling-point of water.

The boiler having been charged with a small quantity of water, and the receptacle filled with sufficient spirit, the boiler is placed upon its support above the burning alcohol, with the Thermometer bulb inserted into the side tube. In a few minutes the boiling-point will be attained, and the mercury in the Thermometer will rise to this point, *and remain in the tube* until it is convenient to note the temperature thus obtained.

If, after the experiment has been made, the Thermometer be carefully withdrawn from the boiler, and *carried with the bulb-end uppermost,* the record of the temperature may be read off hours, or even days, afterwards. The advantages of this apparatus are great simplicity, rapidity in use, and portability.

Price, in a portable case, with an extra Thermometer for air temperatures, £3 0 0

103. **Pocket Hypsometric Apparatus,** as constructed by Negretti and Zambra for Dr. J. D. Hooker, of a very simple and conveniently portable form, with one corrected Thermometer. Suited for rough exploring expeditions.

£2 10 0

APPARATUS EMPLOYED FOR REGISTERING THE DIRECTION, PRESSURE, AND VELOCITY OF THE WIND.

THE records obtained by the use of various forms of Anemometers are equally interesting and valuable.

The amount of pressure and velocity of the wind can now be registered with such precision that it enables Millwrights and Engineers to make their calculations and arrange their machinery in accordance with the amount of work required to be done, and also to test and compare the expected with the actual results.

Meteorologists are equally interested in Anemometer records. The points of direction and the duration of the wind in particular quarters and seasons have very much to do with the Rainfall and Evaporation in different countries and localities. The late Admiral FitzRoy in his *Weather Manual* repeatedly indicates the great importance of careful observations on the various phenomena of the wind in connection with Marine and Sea Coast Meteorology.

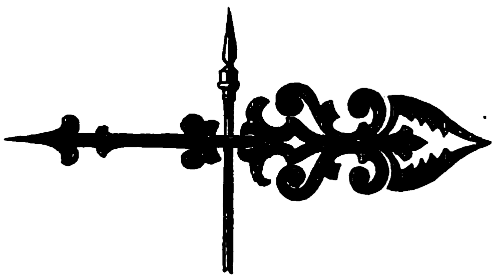


FIG. 81.

104. **Wind Vane,** for indicating the direction of the wind. Figs. 81 and 82.

It is important to note that the North point of the Vane should be adjusted to the *Geographical or true North* and not the Magnetic North.

Negretti and Zambra construct these Vanes of various dimensions and ornamental designs to suit the position in which they are to be placed. As the cost will vary with the amount of work and ornament, no positive prices are quoted, but estimates will be furnished upon particulars being sent of what is desired. Wind Vanes are often fitted up on buildings in connection with Lightning Conductors, particulars of which will be given in another section.

FIG. 82.

105. **Anemoscope.**—Dr. Halleur's Portable Wind Vane and Magnetic Compass, for showing the direction of the wind to half a point of the compass. This instrument is very similar in form and size to Lind's Wind Guage, shown on page 75. Fig. 84. *Price,* £2 5 0

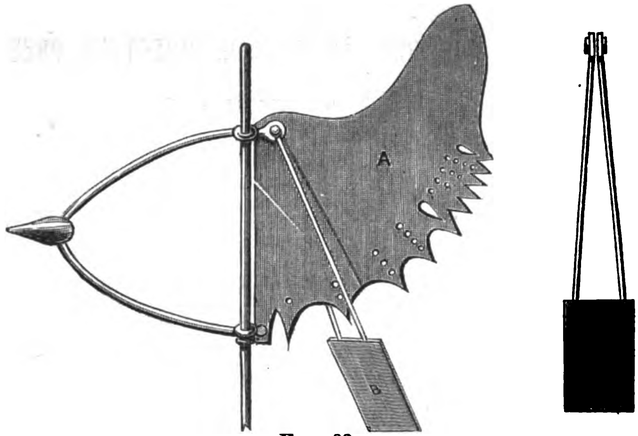


Fig. 83.

106. **Negretti and Zambra's Improved Pendulum Anemometer** invented by Dr. Prestel to exhibit at any moment in a most simple manner the direction and comparative pressure of the wind.

By the action of the peculiar shaped vane A, the surface of the swinging pressure plate, B, is always kept facing the point from which the wind is blowing, and consequently exposed to its influence. During a calm the pendulous plate, B, will hang quite vertical in a line with the axis of the vane plate indicating zero or calm. As the wind increases in force the pressure indicator will be raised to various points between 1 and 10 of the vane.

The holes are drilled through the plate of sufficient size to be plainly visible at a considerable height from the ground; and to facilitate the reading, the 5 and 10 are of a larger conical form, so that the position of the pressure plate can be quickly observed.

The subjoined table gives in English and French measures the value of the indications. The metrical scale is calculated to show the pressure of wind in kilogrammes on the square meter, and the English scale pounds on the square foot.

I. II.

French Measure. English Measure.

Scale of P. A.	Pressure in Kilgr. on S. Mr.	Manheim Scale.	Elevation of Pendulum.	Description of Wind.	Pressure in lbs. on the Sqre. foot.
0.	0	0	0	Calm.	0
1.	1	0.5	5°	Gentle motion of air.	0.2044
2.	4	1.0	20°	Light breeze.	0.8176
3.	9	1.5	35°	Fresh ,, (top gallant W.)	1.8396
4.	15	2.0	45°	Stiff ,, (strong top gallant W.)	3.0660
5.	25	2.5	54°	Very Stiff breeze (top sail W.)	5.1110
6.	36·8	3.0	60°	Strong rushing W. (to house top glt.)	7.5119
7.	49	3.5	64°	Stormy W. (to house top sails.)	10.0156
8.	64	4.0	67°	Gale of Wind.	13.0816
9.	81.6	4.5	69½°	Strong Gale.	16.6790
10.	100	5.0	70°	Hurricane.	20.4408
	143.6	—	74½°		29.3518

Negretti and Zambra think this Anemometer will meet a want often expressed to them, viz., a simple self-acting Wind-gauge; for with very little more mechanical combination than a common direction vane, the Pendulum Anemometer will give sufficiently accurate results for unscientific observers. It has also the advantage of extreme simplicity, for beyond a little oil to the moving parts and an occasional coat of paint for protection, it does not require the least attention. *Price,* £6 6 0

The simplest mode of mounting this Anemometer is to fit it on the top of a flag-staff or mast 30 to 40 feet high, well sunk in the ground, strengthened and supported by three or four wire rope stays, attached to small sunk posts in the earth; these wire ropes might be used as lightning conductors. Arms with the letters N. E. S. and W. to show the direction of the wind as on fig. 72 can be placed on the mast below the Anemometer.

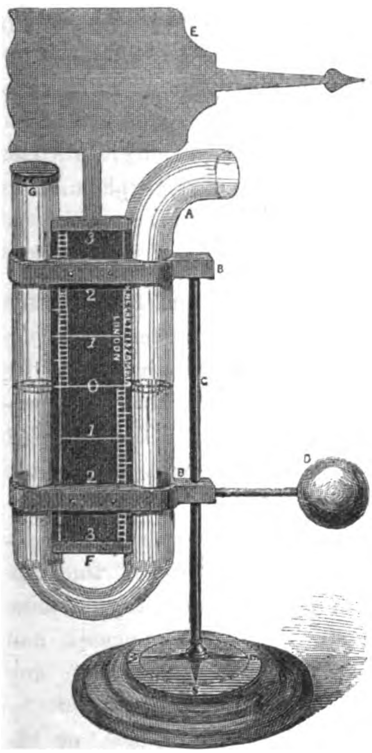


FIG. 84.

107. **Lind's Anemometer or Wind Guage** (fig. 84), invented in the year 1775, for observing the pressure of the wind, consists of a glass syphon, the tubes are parallel to each other, and each tube is of the same diameter. One end of the syphon is bent at right angles to the general direction of the tubes, so as to present a horizontal opening to the action of the wind. A graduated scale, divided to inches and tenths, is attached to the syphon tube, reading either way from a zero point in the centre of the scale. The whole instrument is mounted on a spindle, surmounted by a vane, and is moved freely in any direction by the wind, always presenting the open end of the tube towards the quarter from which the wind blows. To use the instrument it is simply filled up to the zero point with water, and then exposed to the wind; the difference in the level of the water gives the force of the wind in inches and tenths, by adding together the amount of depression in one limb, and elevation in the other, the *sum of the two* being the height of a column of water which the wind is capable of sustaining at that time. At the base of the instrument is a brass plate, upon which are engraved the principal points of the compass, for indicating the direction of the wind. *Price,* £2 2 0

The bend of the syphon is contracted internally to diminish the jumping movement of the water produced by sudden gusts of wind.

Table showing the Force of wind on a square foot, for different heights of the column of Water in Lind's Wind-Gauge.

Inches.	Force in lbs.	Common designation of such Wind.
6	31.75	A Hurricane.
5	26.04	A violent Storm.
4	20.83	A great Storm.
3	15.62	A Storm.
2	10.42	A strong Wind.
1	5.21	A high Wind.
.5	2.60	A brisk Wind.
.1	.52	A fresh Breeze.
.05	.26	A gentle Breeze.
0.	0.	A Calm.

No. 108. **Negretti and Zambra's Registering Lind's Anemometer.** Several modifications of Lind's Wind Guage have at various times been invented by Sir W. Snow Harris, Mr. Wood and others, with a view to make it self-recording, but the only one that proves satisfactory in actual service, is an arrangement manufactured by Messrs. Negretti and Zambra at the suggestion of Mr. Forbes, of Inverness. The improvement consists of a third tube of the same internal diameter, connected by a bend at the Zero point of the instrument, into which the water overflows and is collected from the leeward tube of the syphon. The water thus collected being the maximum amount of depression produced in the syphon representing the extreme force of the wind. *Price,* £3 3 0

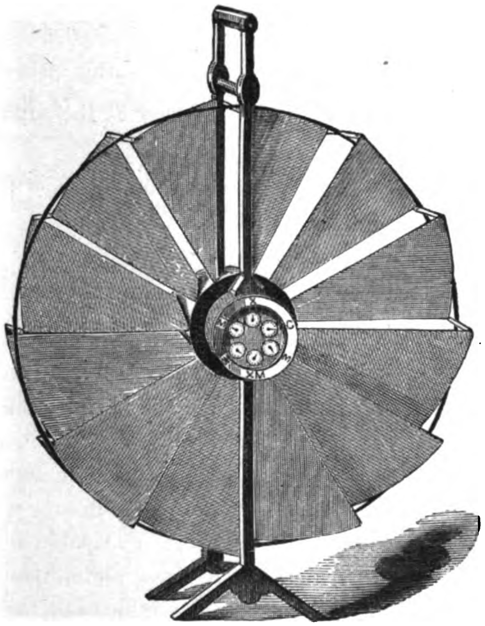


Fig. 85.

109. **Biram's Anemometer** (fig. 85), for registering the current of air in mines, &c., by means of a light vane, the revolutions of which are recorded upon a dial in the centre of the instrument.

This Anemometer self-registers the velocity of the Air through any passage of a mine in which it is placed and is a sure detector of any slackening of the current, by neglect of the furnace, or obstruction in the Air-course, and a complete check against inattention in the furnace-man.

The Registering apparatus is in front of the wheel, and consists in the 12-in. Anemometer (fig. 85) of six small circles, marked respectively

X, C, M, XM, CM, and M, the divisions on which denote units of the denominations of the respective circles; in other words, the X Index in one revolution passes over its ten divisions, and registers (10 × 10) or 100 feet; the C Index in the same way, 1,000 feet; and so on, up to ten million feet; so that an observer has only to record the position of the several indices, at the first observation (by writing the lowest of the two figures on the respective circles between which the index points in their proper order) and deduct the amount from their position at their second observation, to ascertain the velocity of the air which has passed during the interval; this, multiplied by the area in feet of the passage where the Instrument is placed, will show the number of cubic feet which has passed during the same period.

For the purpose of trying and regulating the proportions of Air to the several divisions of a mine, and for the general convenience of overlookers, three smaller instruments, 6 inches, 4 inches, and 2½ inches, with only the X and C indices may be had. They are so portable that they may be carried in a coat pocket, and can be applied in a minute in any part of the mine to ascertain the state of the ventilation. The pocket size of this Anemometer will be found extremely convenient for use in large gun or rifle practice.

Price, 12 inches £4 4s. 6 inches £3 3s. 4 inches £2 10s. 2½ inches £2 2 0

To ascertain the rate at which the air is moving, proceed thus—suppose 100 revolutions=200 feet per minute.

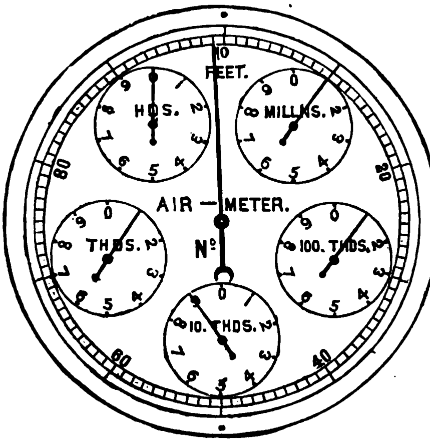
88] 200 [2.27.

Say 2¼ miles per hour—88 being 1-60th of a mile.

To find the force of Wind, multiply the square of the velocity of the wind in feet per second by .0023.

Note.—The velocity of the wind in feet per minute, divided by 88, will give the velocity in miles per hour. (*See above example.*)

Feet per min.	Feet per sec.	Miles per hour.	Force in lbs per square foot.	Description.
50	.83	.568	.0016	Hardly perceptible.
100	1.66	1.136	.0061	Just perceptible.
200	3.33	2.272	.0255	
300	4.99	3.408	.0574	Gentle breeze.
400	6.66	4.544	.1021	
500	8.33	5.680	.1595	
750	12.50	8.522	.3593	Pleasant breeze.
1000	16.66	11.363	.6388	
2000	33.33	22.726	2·5553	Brisk gale.
3000	49.99	34.089	5.6982	High wind.
4000	66.66	45.452	10.2214	Very high wind.
5000	83.33	56.815	16.4429	Storm.
6000	99.99	68.178	22.9954	Great storm.
7000	116.66	79.541	31.3019	Hurricane.
8000	133.32	90.904	40.8807	
9000	149.99	102.267	51.6920	
10000	166.66	113.630	60.8837	



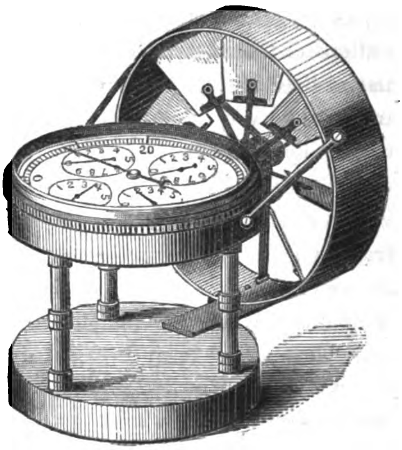


FIG. 85. FIG. 86.

The above engraving of the Dial is the exact size of the Dial of the Instrument.

110. **Improved Portable Air Meter,** for measuring the velocity of currents of Air in Coal Mines and Ventilators, Flues, &c., of Public Buildings, Hospital and Prison Wards, &c., &c. (figs. 85 and 86.)

By means of this Air Meter, the rate at which a current of Air is moving can be ascertained in a few minutes. The Instrument shows from one foot to ten million feet.

The long hand marks up to 100 feet; each division on the large circle represents one foot traversed by the current of air. In setting down a reading of the hands, the long hand takes the units and tens places. The five other hands follow respectively.

EXAMPLE.

	Millns.	100 thds.	10 thds.	thds.	hds.	long hand.
Places the hands take when set down in figures	0 0	0	0	0	0	0 0
Reading of the above diagrams . . .	1	0	9	0	9	9 9

In setting down the position of the hands observe the following rule:—No hand can mark a figure unless the foregoing hand has arrived at the "0." For example, suppose the long hand pointed to 99, the hundreds' hand would appear to point to a figure, but it could not mark the figure until the long hand pointed to the zero. The same rule applies to all the hands. When a hand appears to be between the divisions, write down the lowest figure next the hand.

The catch on the rim of the instrument will stop or allow the hands to run without affecting the action of the fans.

The Meter may be fixed in the current on a rod, fitted into the socket, which screws into the bottom of the instrument.

To take a measurement fix the position of the hands (by moving the catch) write down the reading, and place the Meter in the current of air to be measured. Now put the hands in action by again moving the catch at the same moment, note the time by the second hand of a watch, allow the fans to run in the current for one minute, at the end of which time again put the hands out of action, and again read their position, subtract the

first reading from the second, and the result gives the velocity of the air in feet per minute (uncorrected).

The Meter may be allowed to run in the current of air for any convenient length of time; but, if for longer than one minute, the difference of the first and second readings must be divided by the number of minutes of the running. This gives the (uncorrected) velocity of air for one minute.

A table is supplied with each instrument, showing the necessary correction for friction, &c., at various velocities per minute. In the second column of this table will be found the correction (opposite the velocity shown by the Meter in the first column). This correction, if applied to a measurement of more than one minute, must be multiplied by the number of minutes of the measurement, and added to or subtracted from (according to the sign) the difference of the two readings.

EXAMPLE.

Suppose the first reading to be	5260	
And the second reading after a running of ten minutes is		11060
		5260
The running per minute would be		580
Say the correction for 580 shown by the meter per minute is		82
The real or corrected velocity per minute would be		662

And the real velocity during the running of ten minutes is 6620 feet.

The measurement of the current of air in feet per minute, divided by 88, will give the measurement or velocity in miles per hour.

NOTE.—In taking a measurement the fans must always face the wind, and care should be taken not to bend or injure them.

Price of the Improved Air Meter in a neat Box, figs. 85 and 86 £4 4 0

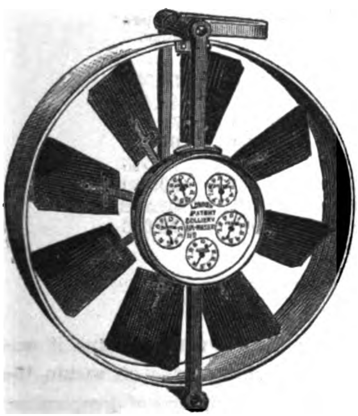


FIG. 87.

111. **Lowne's Patent Colliery Air Meter** constructed expressly for use in coal mines.

The form and external aspect of this Instrument is that of the well-known Biram's Anemometer. The improvements consist of—1st, a large clear Dial; 2nd, the Fan is constructed of a light and anti-corrosive material; 3rd, the Indicating parts are perfectly protected from dust and smoke (this is done by a practical mechanical arrangement); and, 4th, a Lever is placed in a convenient position, to enable the observer to throw the Indicating Wheels in or out of gear from the Fan, for the purpose of taking short observations with accuracy.

6-inch Air Meter, as fig. 87, *Price* £4 10 0

INSTRUCTIONS FOR USING THE AIR METER.

Press the Lever home to the left hand, and the Fans will revolve without moving the Registering Works. Now take a careful reading of the instrument, and write it down; hold the Air Meter in the current by the ring at the top of the Instrument; allow the Fans to run freely for a short time. Now observe the Watch. When the Second Hand reaches the Minute, press the Lever to the right, and the works will be in gear. When the minute is up, again press the Lever to the left hand, to throw the works out of gear; take a reading of the dial and write it down above the first reading, subtract the first reading from the second, and the difference, after the correction is added, will be the velocity of the current in feet per minute, thus:—

Second Reading	9,260
First Reading	8,920
	340
Add correction, say—	40
Rate of current	380 feet per minute.

For measuring currents for a longer space of time, the Air Meter should be suspended on a bar, or fixed in any convenient manner in the current.

The Fans must always face the current, and great care should be taken never to stop them suddenly.

NOTE.—Any one not familiar with Metric Dials must observe that the figures read rationally: thus, if the feet hand is at, say, nine, the tens hand will be near the figure it is approaching. This figure must not be taken, but the previous one that is passed.

Table showing the number of miles per hour at velocities per minute.

Feet per Minute.	Miles per hour.	Feet per minute.	Miles per hour.	Feet per minute.	Miles per hour.
10	.113	200	2.272	3,000	34.090
20	.227	300	3.409	4,000	45.454
30	.340	400	4.545	5,000	56.818
40	.454	500	5.681	6'000	68.181
50	.568	600	6.818	7,000	79.545
60	.681	700	7.954	8,000	90.909
70	.795	800	9.090	9,000	102.272
80	.909	900	10.227	10,000	113.636
90	1.022	1,000	11.363		
100	1.136	2,000	22.727		

"When inquiring into the causes of air currents, either from or within drains, it was suggested that the variable flow of sewage has a powerful influence on the air within the drain, whilst that produced by rainfall has still greater, and the variations of temperature are another cause of displacement and renewal of drain air. A series of observations were taken at the outlets of drains, by Biram's Anemometer at the point of connection with the sewer, and the results proved that up and down currents of air are constantly passing to and fro. Whenever an up-current issues through a drain-opening it must be manifest that some of the inlets of such drains are untrapped, and therefore sewer air must be escaping through such untrapped inlets, to the danger of those who reside in the house."

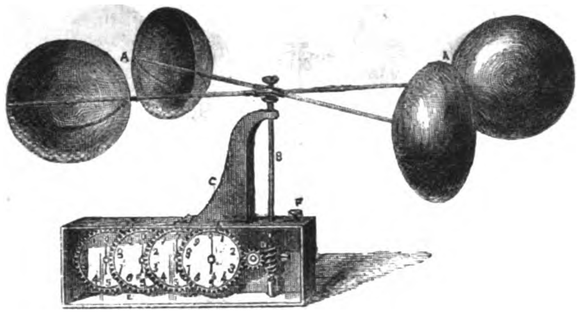


FIG. 88.

112. **Robinson's Anemometer.**—*Dr. Robinson*, of Armagh, is the inventor of this very useful anemometer, for determining the horizontal velocity of the wind. It was first used in 1850, in the meteorological and tidal observations made on the coast of Ireland under the directionof the Rev. Dr. Lloyd. It is represented in its simplest form by fig. 88. Four hollow hemispherical cups, *AA*, are extended upon strong metal arms, with their concave surfaces facing the same way upon a vertical axis, *B*, which has at its lower extremity an endless screw, *D*. The axis is supported and strengthened at *C*, and constructed so as to turn with as little friction as possible. The endless screw on the vertical shaft is placed in gear with a train of wheels and pinions. Each wheel revolves past a fixed index, and the figures and graduations are marked upon the wheels themselves.

The readings on the dials of the Anemometer are as follows: one complete revolution of the *first* stamped index-wheel equals $\frac{1}{10}$ of a mile; the *second*, 1 mile; the *third*, 10 miles; the *fourth*, 100 miles; the *fifth* 1,000 miles; necessarily in noting such reading it must be done backwards, according to the indications on the instrument.

Dr. Robinson has proved by theory and experiment that the centre of any one of the cups mounted as fig. 88 revolves with one-third of the wind's velocity. Therefore allowance has been made for this in graduating the circles, and a true reading is at once obtained. *Price*, fig. 88 £3 3 0 and 4 4 0

113. **Robinson's Anemometer.** Negretti and Zambra's improved arrangement for recording the velocity of the wind, as described by Col. Sir H. James, Royal Engineers. This is a modified form of the Robinson's instrument previously described, our engraving (fig. 89) will show the general details of the mechanism.

It consists of four arms at the end of which there are four light hemispherical hollow metal cups, the concave surfaces facing in one direction and revolving with one-third of the velocity of the current of wind acting on them. On the vertical axis which carries the arms, there is an endless screw, which communicates its real velocity of rotation to a circular dial,

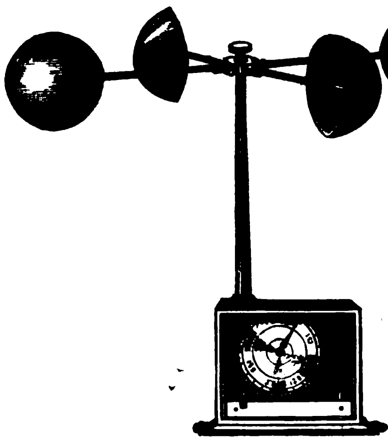


FIG. 89.

This Anemometer is furnished with two graduated circles, the *outer one* being divided into five miles and tenths of a mile, and each division on the *inner circle* represents five miles. One revolution of this circle recording five hundred miles. The *fixed* pointer or index recording on the *outer circle* miles and tenths of a mile to five miles; and the *moving* index records every five miles up to five hundred. If for example the moveable hand stands between 15 and 20 on the *inner* circle and the fixed hand indicates 3 miles and five-tenths the length of the current of air which has passed the station is equivalent to 18 miles and five-tenths.

The velocity of the wind at any particular moment is found by observing the index before and after a certain interval of time as one or five minutes, and then multiplying the rate by 60 or 12 to find the velocity in miles per hour.

The pressure in lbs. per square foot can then be ascertained by reference to tables mentioned in our list of books at the end of this Section. A mill-headed screw at the back of the instrument (fig. 89) turns the moveable index which should be brought back to zero after the observation is registered.

Price, fig. 89, £4 10 0

The Anemometer frame is arranged for screwing on the instrument to a firmly-supported post.

114. **Robinson's Anemometer**, (fig. 90). This drawing shews a further improvement in the recording movement, a *second* dial being added for the convenience of obtaining extended readings.

The left hand dial of this Anemometer is divided and figured exactly the same as in the previously described instrument, and the indications read off in a similar manner. The second dial has 10 divisions, each of these divisions being equal to 500 miles, which is sub-divided by the readings of the left hand dial.

Price, fig. 90, £5 15 0

FIG. 90.

A lever and clutch is sometimes fitted to Robinson's Anemometer, as seen in fig. 91, for throwing the train out of gear when not required to register. Negretti and Zambra having adapted a much simpler mechanism, for producing the same effect to fig. 90, the apparatus shown in No. 91 is now only made to special order. Robinson's Anemometer may also be connected with a train of clock-work so as to be self-recording, by causing the mechanism to impress marks or indents upon prepared paper, moved by the apparatus, at certain intervals of time, but N. and Z. finding No. 118, Beckley's Anemometer very similar and more practically useful, no price is quoted for this form of apparatus.

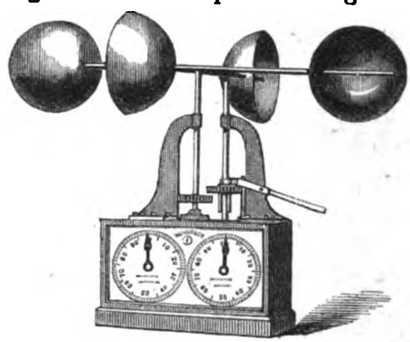


FIG. 91.

115. **Robinson's Anemometer,** mounted in gimbals for Marine Service. This instrument not having been found of much practical value will be made to order.

Robinson's Anemometers should be fixed in an exposed situation, as high above ground as may be convenient for reading. It can be made very portable, by having the arms which carry the cups being fitted to unscrew or to fold down.

116. **Whewell's Self-registering Anemometer,** for recording the amount of horizontal movement in the air, with the direction, for twenty-four hours. A full description of this Anemometer will be found in Negretti and Zambra's Treatise on Meteorological Instruments. It is now rarely used, Osler's and Beckley's arrangements having been found more practically useful.

Price, £25 0 0

117. **Osler's Self-registering Anemometer and Rain Gauge** (fig. 92). This improved arrangement of Anemometer was shown by Messrs. Negretti and Zambra at the International Exhibition, 1862, having Robinson's Cup Anemometer added to it, so that the pressure and velocity appear on the same sheet on which a line, an inch in length, is recorded at every 10 miles. The Improved Anemometer shows the Direction, Pressure, and Velocity of the Wind, also the amount of Rainfall upon one Sheet of paper. Our woodcut is not given as an actual working drawing of Osler's Anemometer, but simply to exhibit the relative position of its several parts. The mechanism may be variously modified, but the following is a description of the most recent and improved arrangement.

Osler's instrument (fig. 92) consists of the vane, *V*, of a wedge-shaped form, which is found to answer better than a flat vane; for the latter is always in a neutral line, and therefore is not sufficiently sensitive. At the lower end of the tube, *TT*, is a small pinion, working in a rack, *r*, which is moved backwards and forwards as the wind alters the position of the vane. To this rack a pencil, *x*, is attached, which marks the direction of the wind on a ruled paper, placed horizontally beneath, and so adjusted as to progress at the rate of half an inch per hour, by means of a simple contrivance connecting it with a clock, which carries the registering paper forward by one of the wheels working into a rack attached to the frame. The paper is shown in the illustration upon the table of the instrument.

The pressure plate, *F*, for ascertaining the force of the wind, is one foot square, placed immediately beneath the vane; it is supported by light bars, running horizontally on friction rollers, and communicating with springs, 1, 2, 3, so that the plate, when affected by the pressure of the wind, acts upon them, and they transfer such action to a copper chain passing down the interior of the direction tube, and over a pulley at the bottom. A light copper wire connects this chain with a spring lever, *y y*, carrying a pencil which records the pressure upon the paper below. Mr. Osler prefers a spring to any other means for ascertaining the force of the wind, because it is of the highest importance to have as little matter in motion as possible, otherwise the momentum acquired will cause the pressure plate to give very erroneous indications. The pressure plate is as light as is consistent with strength. It is kept before the wind by the vane, and is urged out by three or more springs, so that with light winds one only is compressed, and two, or more, according to the strength of the wind.

The *pluviometer*, is placed on the right in the figure, *PP* being the plane of the roof of the building. The rain funnel, *R*, exposes an area of about two hundred square inches. The water collected in it is conveyed by a tube through the roof of the building into a glass vessel, *G*, so adjusted and graduated as to indicate a quarter of an inch of rain for every two hundred square inches of

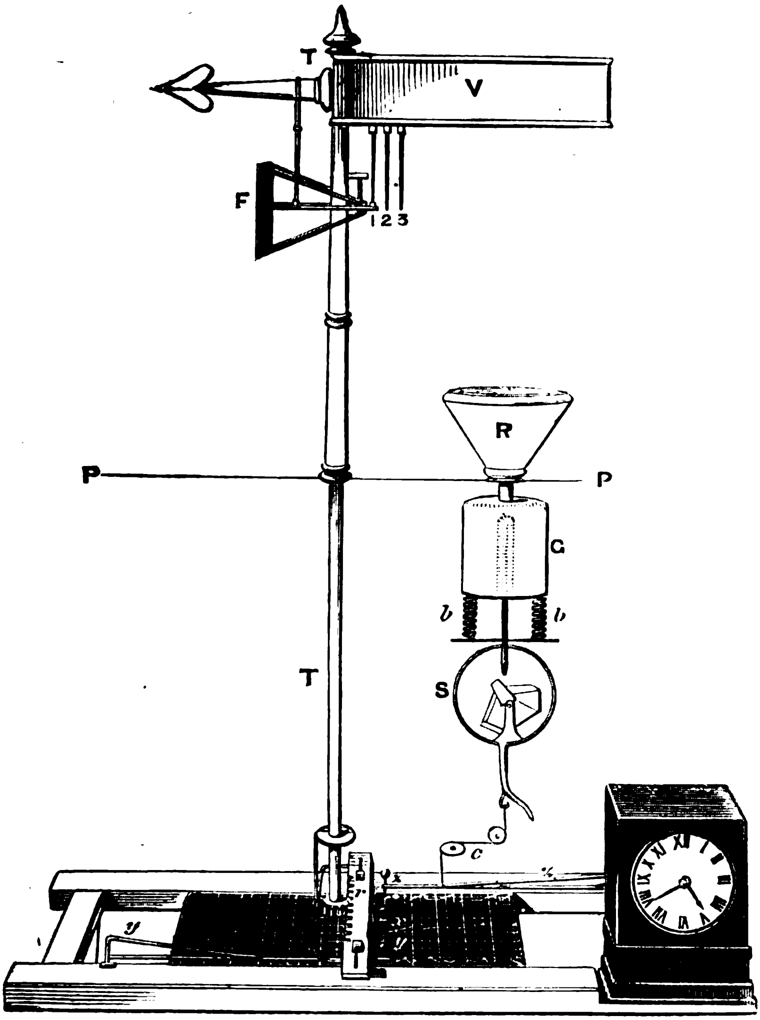


FIG. 92.

surface, *i.e.*, 50 cubic inches. *G* is supported by spiral springs, *b b*, which are compressed by the accumulating rain. A glass tube, open at both ends, is cemented into the bottom of *G*, and over it is placed a larger one closed at the top like a bell glass. The smaller tube thus forms the long leg of a syphon, and the larger tube acts as the short leg. The water, having risen to the level of the top of the inner tube, drops over into a little copper tilt, *t*, in the globe, S, beneath the reservoir. This tilt is divided into two equal partitions, and placed upon an axis not exactly balanced, but so that one end or the other preponderates. The water drops into the end of the tilt which happens to be uppermost, and when quite full it falls over, throwing the water into the globe,

S, from which it flows away by the waste pipe. In this way an imperfect vacuum is produced in the globe, quite sufficient to produce a draught in the small tube of the syphon, or the long leg; and the whole contents of the reservoir, *G*, immediately run off, and the spiral springs *b b*, elevate the reservoir to its original position. To produce this action, a quarter of an inch of rain must have fallen. The registration is easily understood. A spring lever, *z*, carrying a pencil, is attached by a cord, *c*, to S. This spring always keeps the cord tight, so that as the apparatus descends during the fall of rain, the spring advances the pencil more and more from the zero of the scale upon the paper beneath, until a quarter of an inch had fallen, when the pencil is drawn back to zero by the ascent of the reservoir.

The registration trace for twenty-four hours is readily understood. The direction is recorded on the centre part; the pressure on one side, and the rain on the other. Lines parallel to the length of the paper show no rain, steady wind, and constant pressure. On the rain-trace, a line parallel to the width of the paper, shows that the pencil had been drawn back to zero, a quarter of an inch of rain having fallen. The hour lines are in the direction of the width of the paper.

Price, for Osler's Self-registering Anemometer and Rain Guage from £85 to £150

118. **Beckley's Anemometer.**—Mr. R. Beckley, of the Kew Observatory, has devised a self-registering anemometer, which consists of three principal parts: Robinson's cups for the determination of velocity; a double fan, or windmill governor, for obtaining the direction; and a clock to move a cylinder, around which registration paper is wrapped. The paper records the time, velocity, and direction of the wind for twenty-four hours, when it must be replaced. It has a cast-iron tubular support, or pedestal to carry the external parts—the cups and the fans,—which must be erected upon the roof of the building upon which it is desired to mount the instrument.

The fans keep their axis at right angles to the wind; and with any change of direction they move, carrying with them an outer brass tube, which rests upon friction balls on the top of the pedestal, and is attached to a tubular shaft passing through the interior of the pedestal, and terminating with a mitre wheel. The mitre wheel, working with other cogged wheels, communicates the motion of the direction shaft to a cylinder carrying a pencil, to record the direction.

The shaft carrying the cups is supported upon friction balls, placed in a groove formed on the top of the direction shaft, and passing through the interior of that shaft, comes out below the mitre wheel, where it is terminated in an endless screw, or worm.

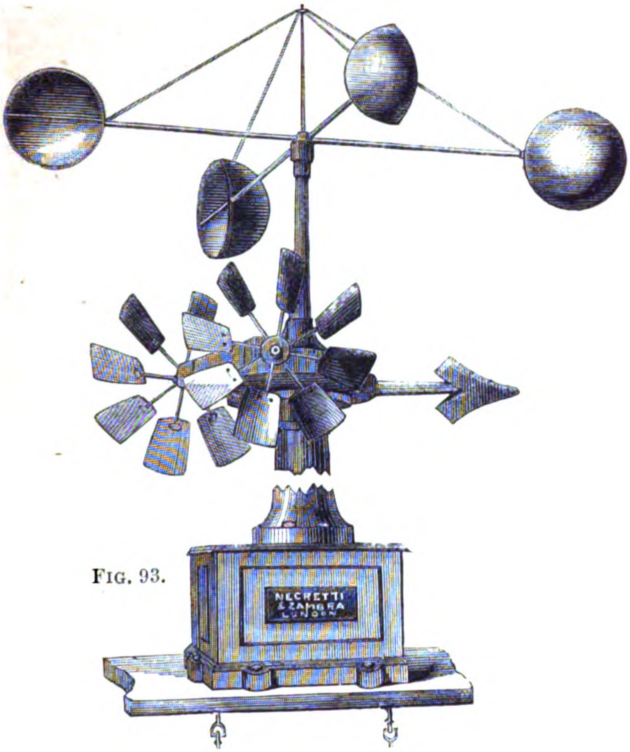


FIG. 93.

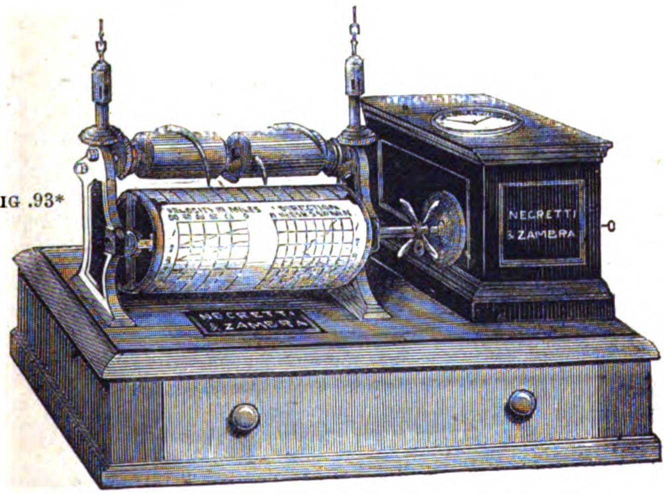


FIG .93*

BECKLEY'S RECORDING ANEMOMETER.

Upon the wind moving the cups, motion is given to the innermost shaft, thence to the worm-wheel, whence motion is given to a pencil which registers the velocity.

De La Rue's metallic paper is used in registration, it having the property of receiving a trace from a brass pencil. The pencils can, therefore, be made in the most convenient form. Mr. Beckley forms each pencil of a strip of brass wrapped round a cylinder, making a very thin threaded screw, so that the contact of the pencil cylinder and the clock cylinder is a mere point of the metallic thread. The pencil cylinders are placed side by side upon the drum turned by the clock, and require no spring or other appliance to keep them to their work, but always make contact with the registration paper by their own gravity. They therefore require no attention, and being as long as the trace which they make they will last a long time.

The velocity pencil has only one turn on the cylinder, and its pitch is equal to a scale of fifty miles upon the paper. The direction pencil has likewise one turn on its cylinder, its pitch being equal to a scale of the cardinal points of the compass upon the paper.

The clock gives a uniform motion of half an inch per hour to the drum upon which the paper is secured.

In the Report of the British Association for 1858, Mr. Beckley has given a detailed description of his Anemometer, with drawings of all the parts.

Our engravings (figs. 93 and 93*) show the general arrangement and details of this Anemometer.

The price of Beckley's Anemometer depends so much upon the fittings and the amount of work required to suit it to the building upon which it is to be fixed that Negretti and Zambra can only quote £80 to £100 as the probable cost of the instrument.

119. Negretti and Zambra's Anemometer as erected on their Holborn Viaduct Establishment, shewing direction and pressure on dials in the base of the building. Cost according to position in which it is to be fixed.

Estimates given.

120. Our List of Registering Anemometers will hardly be deemed complete without the mention of some exceedingly ingenious contrivances for obtaining records of the movements of the wind by the use of a galvanic current so arranged that any alteration in the direction or force of the wind is instantly carried down to a dial or revolving drum or other mechanical contrivance for receiving the indications.

A very elaborate description will be found in Kaemtz's *Meteorology*, of Professor Wheatstone's *Electro-Magnetic Meteorological Register*, and in several foreign meteorological publications will also be found details of many similar applications of the electric current.

Louis J. Crossley, Esq., of Halifax, has devoted a very large amount of time and attention in perfecting a recording modification of Robinson's Anemometer, in connection with a galvanic receiving and transmitting apparatus with considerable success; but owing to the difficulty of maintaining the connections and contact breaks in perfect working order, and the consequent probability of defects in the registration, the Electro-Magneto Anemometers are rarely used. N. & Z. construct these instruments to order and drawings.

APPARATUS FOR TESTING THE ELECTRIC CONDITION OF THE ATMOSPHERE.

121. **Ozone.**—During the action of a powerful electric machine, and in the decomposition of water by the voltaic battery, a peculiar odour is perceptible, which is considered to arise from the generation of a substance to which the term *Ozone* has been given, on account of its having been first detected by smell, which, for a long time after its discovery was its only known characteristic. A similar odour is evolved by the influence of phosphorous on moist air, and in other cases of slow combustion. It is also traceable, by the smell, in air,—where a flash of lightning has passed immediately before.

Ozone according to Faraday is oxygen in an altotropic condition, and from the observations of Mr. Glaisher is to be found almost always present in the atmosphere; the quantity depending on the elevation above the surface of the earth, and the prevalence of particular winds, being more abundant during southerly than during northerly winds, and at a high elevation than at the surface of the earth. It is more abundant at the sea-side than inland, and is almost absent in thickly-populated towns. This may seem, remarks Admiral FitzRoy, in *The Weather Book*, to point to some connection between ozone and chlorine gas, which is present in and over sea water, and which is no doubt brought inland by any wind blowing from the sea.

Ozone plays an important part in the purification of the atmosphere, and its continued presence in a locality indicates a pure and healthy climate. More and careful observations are however required before its true functions can be determined.

Dr. B. W. Richardson, F.R.S., in a Lecture on Vital Air, delivered at the Society of Arts, states, as an undoubted fact, that he found that oxygen which had been rendered prejudicial to animal life from repeated breathing was restored by means of an electric discharge to its original exhilarating state, and was again capable of supporting animal life. So that there is, possibly, a very close relation between the electrical condition of the atmosphere and the amount of ozone present, as indicated by the Ozonometer. The ozone is usually in excess during disturbed electrical weather, and in a deficiency during calm and settled periods. These facts open up a most interesting study in Meteorology, and should lead the observer to mark accurately all the circumstances that tend to exalt or retard the development of ozone—an element so nearly connected with the purity of the air we breathe, and so essential to the healthiness of any locality selected for habitation. We cannot lay too great a stress on the fact that where different kinds of ozone tests are made use of by different observers, no uniformity in results can be attained. Having this in view, we have prepared our ozone tests (see No. 123) on a formula, by which we can obtain absolute uniformity in the indication and results that can be compared

accurately, no matter how far the stations may be removed from one another or how long a period elapses between the observations. It is important to note this, as we are receiving frequent complaint of the uncertainty and failure of other Ozone Test Papers. It is recommended to take observations every twelve hours where practicable, as there is a marked difference in the amount of ozone registered in the day and night.

APPARATUS FOR PRODUCING OZONE.

121.* **Ozone Tube.**—A simple form of apparatus for the production of Ozone. It consists of a glass tube about ¾ of an inch diameter, and 5 or 6 inches in length, coated outside with tinfoil and enclosed in an outer tube, also covered outside with tinfoil. These tubes are so arranged that the intervening space between the tubes shall be as small as possible. The coating of the *inner* tube being put into connection with the terminal of the secondary coil of an inductorium, and the outer coating connected with the other terminal of the same coil. The apparatus forms, in fact, a kind of Leyden Jar, and air or oxygen passing between the tubes when the coil is in action becomes very strongly ozonized. The air to be operated on is either to be drawn or forced through the apparatus by the aid and use of an Aspirator or Gasometer.

Price for the above, conveniently mounted . . . £1 5 0

122. Ozone may also be made by passing a current of dry air or oxygen from a gasometer through a narrow glass tube, bent for convenience like the letter U, about three feet in length, and containing a platinum wire two feet in length, inserted into the interior of the tube, and one end of which communicated with the outside through the wall of the tube. Round the whole external surface of this U-shaped tube a spiral of copper wire is to be coiled, and an induction current (from a coil giving half-inch sparks), is to be passed between the external copper to the internal platinum wire, so as to have the platinum wire as the *negative pole* in the interior of the glass tube. After a stream of gas is ozonised by the transmission of the induction-current, it is to be washed by passing it through a bulb-tube containing caustic potash, when air is employed, or water when pure oxygen is used, in order to eliminate any traces of nitrous and nitric acids that may have been formed. By means of a gasometer the volume of gas passing through the tube may be exactly ascertained.

122.* In the *American Journal of Pharmacy* of September, 1876, Mr. Lender gives the following formula for producing *Artificial Ozone*, Permanganate of Potassium, Peroxide of Manganese, and Oxalic Acid, equal parts. When this mixture is placed in contact with water, Ozone is quickly generated. For a room of medium size, two teaspoonfuls of this compound placed in a dish and occasionally diluted with water is found sufficient. The Ozone develops itself and disinfects the surrounding air without producing cough. This

preparation having been recommended in several publications we insert it chiefly for the purpose of *warning* our readers of its very dangerous nature, it being a most explosive compound, a small amount of friction being sufficient to detonate it, and produce most disastrous results. Only very small quantities should be prepared at one time, and the powders which should be levigated *separately* and only *coarsely*, are to be mixed cautiously with *a wood or bone spatula on paper*, by no means use a pestle and mortar. We again repeat our caution that both in preparation and use it is a most dangerous compound.

The apparatus described at No. 122, was used by Mr. Dewar and Dr. McKendrick in carrying out some experimental research on the Physiological Action of Ozone, the results being communicated by them to the Royal Society of Edinburgh. In their paper the authors point out that little was known regarding the action of Ozone, except its peculiar smell and the irritating effect it had on the mucous membrane of the respiratory tract. Schönbein had shown that a mouse died in five minutes in an atmosphere highly charged with Ozone; and it was this distinguished investigator who asserted that there was a relation between the quantity of Ozone in the air and the prevalence of epidemic diseases.

The result of Messrs. Dewar and McKendrick's experiment was, that a full-grown, healthy mouse lived nineteen minutes after the introduction of ozone into the confining vessel, and that in ozonised oxygen, instead of dying at the end of fifteen or twenty minutes, (as happened to mice in ozonised *air*), they lived for forty or sixty minutes.

In concluding the paper the authors stated that it would be premature, at this stage of the inquiry (which opened up many points of interest in the physiology of respiration), to generalise between physiological action and the physical and chemical properties of ozone; but they pointed out the fact that the density of ozone ($O_3 = 24$) is slightly greater than that of carbonic acid ($CO_2 = 22$); and that although the chemical activity of the substance is much increased, yet, when inhaled into the lungs, it must retard greatly the rate of diffusion of carbonic acid from the blood, which accounts (from the accumulation of CO_2) for the venous character of that fluid after death. From this point of view, destruction of life by ozone (with the exception of its irritant action) resembles that caused by an atmosphere surcharged with carbonic acid. This has been found to be the case more especially as regards the diminished number of respirations per minute, and the appearance of the blood after death. If, however, the analogy were perfect, the inhalation of an atmosphere of ozonised oxygen would not have produced death, because it is now well known, as shown by Regnault and Reiset, that animals can live in atmosphere containing a large per-centage of carbonic acid, provided there is an excess of oxygen present. The amount of oxygen in these experiments converted into ozone certainly never exceeded ten per cent. But the authors have observed that an animal lives only a somewhat longer time in *ozonised*

FIG. 94.

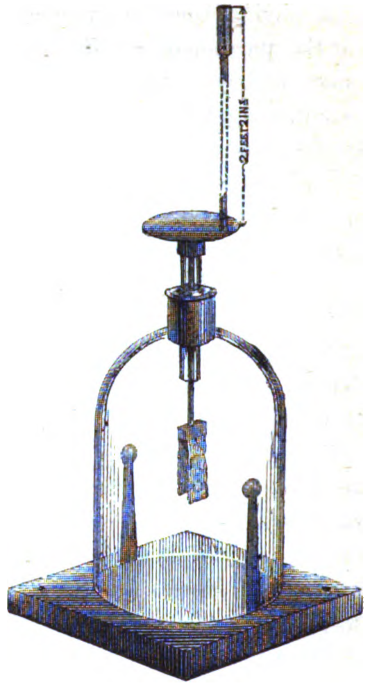


FIG. 95.

oxygen than in *ozonised air;* and they are thus induced to regard ozone as having some specific action on the blood that their future experiments may elucidate. Series of researches are still being prosecuted (*a*) on the action of smaller percentages of ozone; (*b*) on the action of ozone on noxious gases and effluvia; and (*c*) on any therapeutical or hygienic influences it may have on the origin and treatment of zymotic diseases.

123. **Negretti and Zambra's Ozonometer.** These tests are now prepared on a new formula by which perfect uniformity in the indications is secured together with greater sensitiveness and keeping qualities.

In Tin Boxes sufficient for 12 months' observations, with colour scale and full instructions for use . . . . *Price*, 8s. 6d.

124. **Ozonometer.**—Dr. Moffatt's Ozonometer consists of strips of paper prepared with Iodide of Potassium and Starch; the papers are suspended in a box or otherwise, so as to be exposed to the free access of air, but not to the direct rays of the sun. The paper when affected by ozone is tinged with various shades of brown, the intensity of which is measured by a scale of ten gradations furnished with the ozonometer. *Price*, 8s. 6d.

125. **Schonbien's Ozone Tests** *Price*, 6s. 6d.

126. **Ozone Box,** constructed of painted deal on the plan recommended by Dr. Moffatt. *Price*, £1 1 0

127. **Sir James Clarke's Ozone Case** (fig. 94), consists of two cylinders of

very fine wire gauze, one fitting into the other; the wire gauze being of such a fineness as to permit the free ingress of air, at the same time that it shuts out all light that would act injuriously on the test paper, which is suspended by a clip or hook attached to the upper part of the inner cylinder. *Price*, £0 18 0

Ditto in copper £1 5 0

128. **Lowe's Ozone Case**, Spiral form, japanned zinc. *Price*, £0 18 6

129. **Registering Ozonometer**, Dr. E. Lankester's, with clock motion, for exposing a given surface of Test Paper a certain time.

Made to order, *Price*, £12 12 0

130. **Atmospheric Electricity.**—The *general* electrical condition of the atmosphere is *positive* in relation to the surface of the earth and ocean, becoming more and more positive as the altitude increases. When the sky is overcast, and the clouds are moving in different directions, it is subject to great and sudden variations, changing rapidly from positive to negative, and the reverse. During fog, rain, hail, sleet, snow, and thunderstorm, the electrical state of the air undergoes many variations. The intensity of the electricity increases with hot weather following a series of wet days, or of wet weather coming after a continuance of dry days. The atmospheric electricity, in fact, seems to depend for its intensity and kind upon the direction and character of the prevailing wind, under ordinary circumstances. It has an annual and a diurnal variation. There is a greater diurnal change of tension in winter than in summer. By comparing observations from month to month, a gradual increase of tension is perceived from July to February, and a decrease from February to July. The intensity seems to vary with the temperature. The diurnal variation exhibits two periods of greatest and two of least intensity. In summer, the *maxima* occur about 10 a.m. and 10 p.m.; the *minima* about 2 a.m. and noon. In winter, the *maxima* take place near 10 a.m. and 8 p.m.; the *minima* near 4 a.m. and 4 p.m.

131. **Singer's Electrometer for Atmospherical Electricity.** (fig. 95).—This instrument is arranged with a brass rod about two feet in length, and a clip for the reception of a lighted cigar fusee; the electricity is collected by the flame, and conducted down the rod to a pair of gold leaves, which separate according to the amount; the kind is determined by the effect of either a stick of excited sealing-wax, or a glass rod, supplied with the instrument.

A glass rod when rubbed produces *positive* electricty; a stick of sealing-wax similarly treated produces *negative;* if, therefore, when the leaves are separate, we apply an excited glass rod, and they separate still further, the electricity is *positive;* if they approach it is *negative;* on the contrary, if we use a stick of sealing-wax, the leaves will separate if they are charged with *negative* electricity, and converge if *positively* charged, from the fact that all bodies similarly electrified repel each other, whilst those oppositely electrified, attract each other. *Price*, £1 1 0

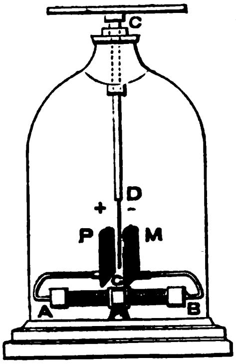


FIG. 96.

FIG. 97.

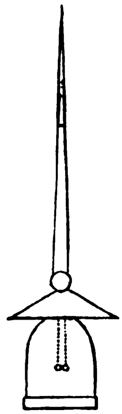


FIG. 98.

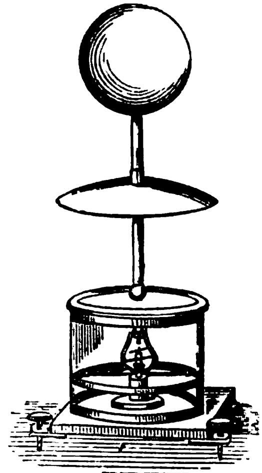


FIG. 99.

A book containing strips of gold leaf, to replace the gold leaves when torn or broken in use. *Price*, £0 1 6

To mount fresh gold leaves, unscrew and withdraw the brass plate to which is attached the rod supporting the leaves; then moisten with the breath the flat piece of brass, and press it gently down on one strip of gold, whilst the book is only partly opened; the second leaf is attached in the same manner.

132. **Bohnenberger's Electroscope** (fig. 96), with Zamboni's Dry Piles, arranged with adjustments for regulating the distance between the gold leaf and the polar plates, an exceedingly delicate instrument for indicating the presence and quality of electrical currents.

It can be mounted with a metallic conductor, and used with great advantage for observing atmospheric electricity. The principal parts of the instrument, as improved by Becquérel, are the following:— *A B*, fig. 96, is a small Zamboni's dry galvanic pile of 800 pairs, about a quarter of an inch in diameter; and when the plates are pressed together, 2½ inches in length. The bent wires above the pile, terminate in two plates, *P* and *M*, which are the poles of the pile. These plates are parallel and opposite to each other. Their opposite sides are slightly convex, and gilded; between is suspended a fine gold leaf, *D G*, which is attached to the metal conductor, *C D*. If the leaf hang exactly between the two plates, it is equally attracted by each, and will be in a state of repose. The apparatus is protected by a glass-shade, having an opening at the top through which the metal wire, *C D*, passes, insulated by being contained in a glass tube, which is cemented to the glass shade by means of shellac. A metal plate is attached to the wire rod in connection with the gold leaf to convey to it the electricty to be tested. The electricty to be tested, will be conveyed by the metal wire to the gold leaf, and the latter will immediately

move towards the plate which has the opposite polarity. This electroscope is, beyond doubt, one of the most delicate ever constructed, and is well adapted to show small quantities of positive and negative electricty. *Price*, £8 8 0

133. **Volta's Straw Electrometer,** with graduated arc for estimating the amount of electric force by degrees of divergence. *Price*, £2 2 0

134. **Cavallo's Pith Ball, Electroscope,** (fig. 98.) with graduated arc, for estimating the amount of electric force . . . . *Price*, £1 10 0

135. **Ditto** ditto with Stopcock, fig. 97 . . . 2 2 0

136. **Peltier's Tension Electrometer**, (fig. 99) according to Mr. Latimer Clark, was in all its essential parts first described and illustrated by Dr. Thomas Milner in the year 1733. The instrument described as the invention of Peltier in the Report of the British Association, 1849, and termed the Induction Electrometer is constructed as follows:—

It consists of a light metal ball of about 4½ inches diameter mounted on a brass rod, terminating in a flattened oval or heart shaped aperture. In the centre of this aperture is placed a fine steel point on which is suspended a light copper or aluminum wire needle, with a small magnetic needle mounted on it at right angles. Two light metal rods or arms are extended from opposite sides of the support of the ball of the same length as the copper needle. Below these rods is a graduated circle, for estimating the value of the deflexion of the needle in degrees. The support of the ball and centre of the needle is very carefully mounted and insulated on ebonite, and the whole mounted on a mahogany base with three adjusting screws. A cylindrical glass cover is placed over the graduated circle and indicating needle to protect them from currents of air, dust, &c.

In use this electrometer is very carefully placed in such a position that the magnetic needle shall cause the light copper wire index needle to lie parallel with and almost touching the two brass arms when if the apparatus has been properly adjusted, if any cloud or portion of air in its vicinity be in an electrical condition it will act by induction upon the metal ball and the needle will be deflected according to the amount and tension of the electricity.

The quality of the electricity if positive or negative may be ascertained by the use of a rod of glass or shellac as described in directions for using the gold leaf instrument.

In atmospheric observations the instrument may either be charged with free electricity and the indications of this needle noted at certain intervals, or it may be brought to the same degree of tension as the earth, and the inductive effects of the atmosphere upon it observed. Owing to its greater convenience the former method is now generally adopted, but the variations of the needle under atmospheric influences are far from being understood or reduced to a system.

In use the Induction Electrometer is placed upon a stand about six feet from the ground, and to bring it into equilibrium of tension with the earth, touch

the base of the stem with a conducting wire. When the instrument is removed from the inductive influence it indicates the presence of free electricity by the deflection of the needle.

A regular and uninterrupted series of atmospheric observations with the Peltier instrument were made by M. Quetelet at the Royal Observatory at Brussels from August, 1844, till December, 1848.

A strong inductive influence was generally noticed at the approach or cessation of rain. The maximum of atmospheric electricity was indicated in January, the tension of the atmospheric charge progressively diminishing until June, when it attained its minimum. The difference of the tension in these two months was in the proportion of 13 to 1. The résults obtained by Mr. R. Birt at Kew are closely in accordance with those of M. Quetelet.

Peltier's instrument is now constructed with a smaller ball, and without the metal shade as shown in our engraving, and the whole apparatus carefully insulated with ebonite (vulcanite), in place of shellac and resin. *Price,* £5 5 0

137. **Professor W. Thomson's Atmospheric Electrometer** will be found fully described in Negretti and Zambra's *Treatise on Meteorological Instruments*, paragraph 135, pp. 130 and 131.

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138. We have still to note the want of a portable and simple, but at the same time, accurate instrument to denote the electrical condition of the atmosphere. Many forms of Electrometers lately devised are but of little use to ordinary observers from their complex construction.

139. **Collection of Electricity.**—" A simple rough method of doing this is to shoot a metallic arrow upwards into the air, the arrow being tied to one end of a conducting string, the lower end of which carries a ring which rests upon the electroscope. The arrow being shot upwards, the electroscope will be found to be electrified, as it mounts; and when the ring leaves the plate, the instrument will indicate the state of electrification of the air at that point where the arrow is at the time.

" This manner of observing is simplified by substituting a long conductor reaching upwards; a gilded fishing rod may be employed, its lower extremity being insulated.

" The usual method employed, however, is Volta's, in which the electricity is collected by means of a flame, burning at a height, either in a lantern hung to a mast, and connected to the electroscope by a wire, or, by a slow burning match, attached to the top of a long metal rod.

" The electricity of the air, in the neighbourhood of the flame, by its inductive action upon the conductor, causes electricity of the opposite nature to accumulate at the upper extremity, where it is constantly carried off by the convection currents in the flame, leaving the conductor charged with electricity of the same kind and potential as the air." *

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* Robert H. Scott, Esq., Meteorological Office.

139. **Tide Gauge, Self-registering, Negretti and Zambra's Improved Newman's** (fig. 100), for recording the rise and fall of the tide, by a line traced with a pencil on a ruled paper, wound on a cylinder moved round by a clock once in twenty-four hours. The paper showing the rise and fall in feet and inches, and also the time in hours. An exceedingly valuable instrument for places where the phenomena of tides, and the construction of accurate tide tables are of the utmost importance. Such observations should also be accompanied with the registration of atmospheric phenomena.

The tide-gauge, shown in the illustration (fig. 100) consists of a cylinder, *A*, which is made to revolve once in twenty-four hours by the action of the clock *B*. A chain, to which is attached the float, *D*, passes over the wheel, *C*, and on the axis of this wheel, *C* (in about the middle of it), is a small toothed wheel, placed so as to be in contact with a large toothed wheel carrying a grooved pulley, *E*, over which passes a small chain. This chain, passing along the upper surface of the cylinder, *A*, and round a second pulley, *F*, at its further end, is acted on by a spring so as to be kept in a constant state of tension. In the middle of this chain a small tube is fixed for carrying a pencil, which, being gently pressed down by means of a small weight on the top of it, marks on the paper placed round the cylinder the progress of the rise or fall of the tide as the cylinder revolves, and as it is drawn by the chain forward or backward by the rise or fall of the float. The paper is prepared with lines equi-distant from each other, to correspond with the hours of the clock, *A*, crossed by others showing the number of feet of rise and fall.

The cylinder while in action revolves from left to right to a spectator facing the clock, and the pencil is carried horizontally along the top of this cylinder; the large wheel, *C*, is caused to revolve by the rise and fall of the float, which turns the wheel with the small pulley, *E*, attached to it. If the tide is *falling*, the small chain is wound round the cylinder, *E*, and the pencil is drawn towards the large wheel; but if the tide is *rising*, the small chain is wound on the cylinder, *F*, by means of the spring contained in it. Thus, by means of the rise and fall of the tide, a lateral progress is given to the pencil, while the cylinder is made to revolve on its axis by the clock, so that a line is traced on the paper showing the exact state of the tide continuously, without further attention than is necessary to change the paper once every day, and to keep the pencil carefully pointed; or a metallic pencil may be used. As indicated, it is self-recording, requiring very little attention—a few minutes every day being sufficient.

These gauges are now in action in several parts of the world, *faithfully* recording the rise and fall of the tides. *Price*, fig. 100 from £42 0 0

NOTE.—The price for the Ruled Papers or Charts used with this Apparatus and No. 140, along with Charts for other Recording Instruments, will be found on page 110.

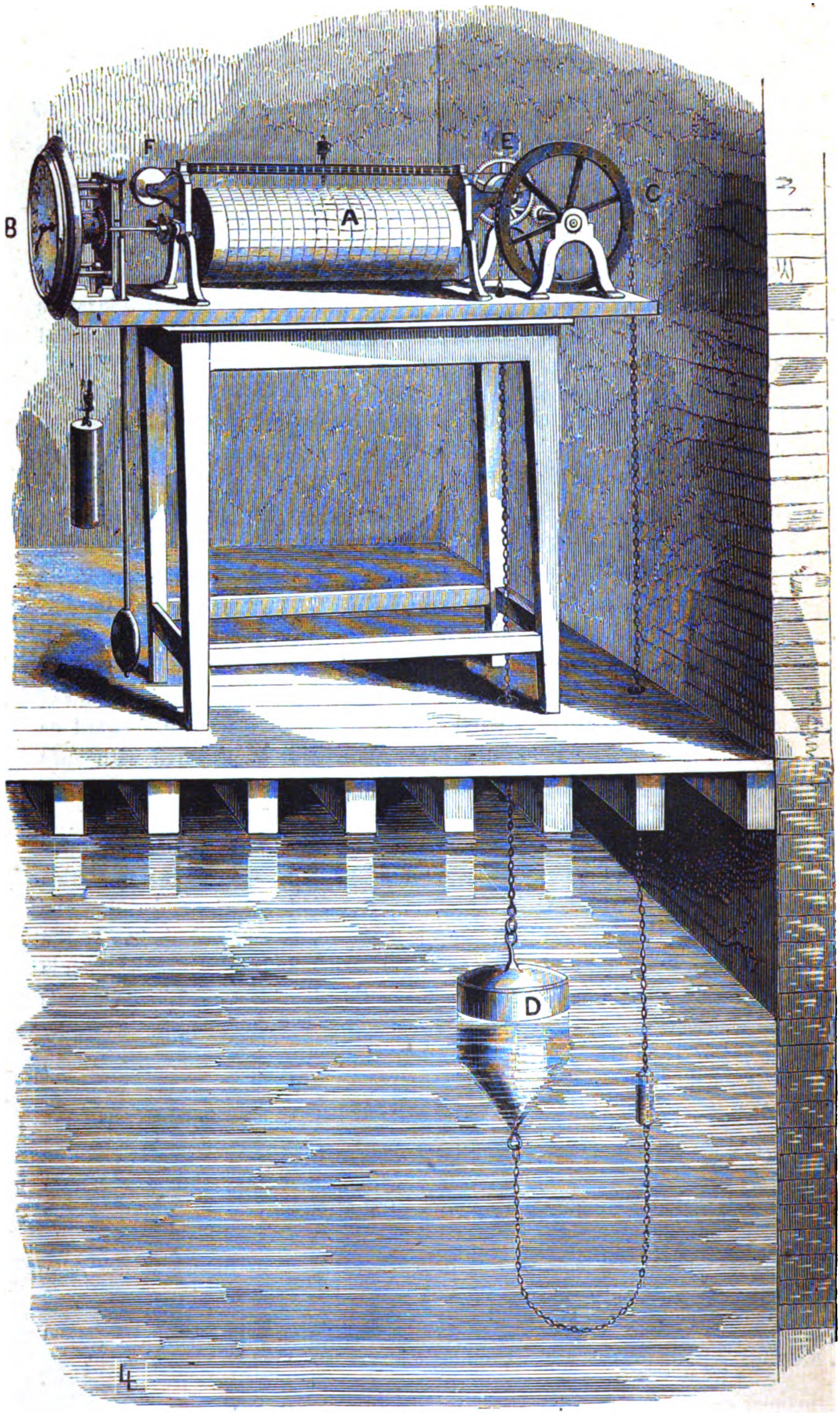
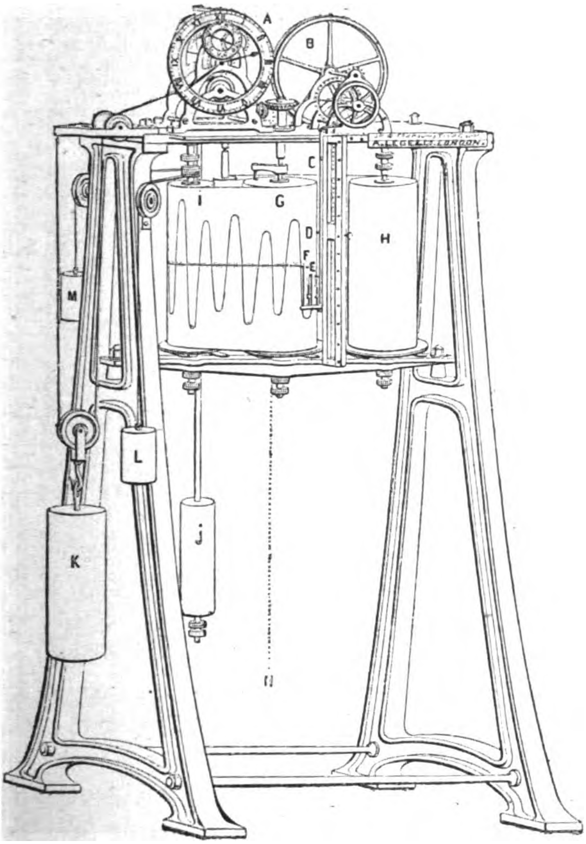


Fig. 100. NEGRETTI AND ZAMBRA'S NEWMAN'S IMPROVED SELF-RECORDING TIDE GAUGE.



A. Dial of clock.
B. Float-wheel.
C. Guide for recording pencil.
D. Recording pencil.
E. Hourly marker on datum lines.
F. Datum lines and registering pencil.
G. Main Drum driven by clock.
H. Reel of paper.
I. Haul-off drum.
J. Pendulum of clock.
K. Driving weight of clock.
L. Driving weight of haul-off drum.
M. Haul-off drum winder.
N. Platinum wire to float.

FIG. 101.

SIR WM. THOMSON'S TIDE-GUAGE.

140. The instrument consists of an astronomical clock, float-wheel and gear-work for reducing the scale, and three drums, the whole fitted on a suitable plate and supporting standards, and requiring no further fixing. The clock is fitted with a six-spur gravity escapement and compensated pendulum, and serves to show the time and to drive the centre or main drum of the instrument. The float wheel is provided with a right-angled groove in which the platinum wire of the float coils itself during the rising tide. The right-hand drum receives a reel of paper, and the paper is fitted to the instrument without further fixing. The haul-off drum receives the paper records after it has passed round the main drum. The paper may be left to accumulate almost without limit on the haul-off drum, or can be removed at any time. The datum line on the record paper is traced by a fixed pencil, which can be adjusted to any level. Any number of horizontal lines can be ruled in this manner if desired.

Immediately at the side of the datum line registering pencil, is a pencil actuated by the clock, which causes it to trace a short vertical line at each hour, through the datum lines, the mark for noon and midnight being somewhat different. In this case the pencil is arrested for two minutes when in marking it has reached the level of the datum line, when it is allowed to complete the marking. This distinction is introduced in order to facilitate the subsequent noting of the times and dates upon the record. The pencil tide recorder is made to counterbalance the float-wire when the scale is not too greatly reduced, in which case, the weight of the float-wire is partially relieved by a counterpoise weight acting on the axis of the float-wheel. The system of making the recording pencil balance the float-wire is a great advantage over the system generally employed and greater accuracy of recording is secured. The employment of a continuous roll of paper obviates the necessity of continually applying fresh paper to the recording drum, and the tide-guage can thus be left untended, except for the purpose of winding the clock, for an indefinite period. The system also of ruling the paper by fixed pencils and marking the hourly times by the clock constitutes a marked improvement, no error can thus occur from the wrong setting of the paper.

Prices.	The Tide-guage with three barrels and continuous paper complete, best finish		£95
	Ditto	with single barrel and extra finish . . . . fig. 101.	£80
	Ditto	ditto to be used with previously divided paper .	£54

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141. **Negretti and Zambra's Portable Set of Meteorological Instruments.** A small, but at the same time really useful and reliable set of Standard Meteorological Instruments has long been inquired for by observers on foreign stations, and others who are frequently travelling to different parts of the world. To meet this demand, Messrs. Negretti and Zambra have arranged sets of Meteorological Instruments to pack up into a very small space. The set contains Negretti and Zambra's Patent Maximum and Minimum Registering Thermometers, Wet and Dry Bulb Hygrometer, Aneroid Barometer for Altitude measurements, Improved Registering Maximum Thermometer with high range of scale, for Hot Springs, Solar Radiation Thermometer, Terrestrial Radiation ditto, Improved Boiling Point Apparatus, Rain Gauge and Graduated Measure, a Clinometer, Magnetic Compass, and Tape Measure. The whole arranged in strong travelling case, with lock and key. *Price* £18 18 0

These sets can be varied, or other Instruments added, to meet the wishes and requirements of purchasers. See also pages 106 and 107.

Further details of the construction and use of Meteorological Instruments will be found in Negretti and Zambra's TREATISE, *with very many valuable and useful tables of corrections, &c., &c. See page* 109.

NEGRETTI AND ZAMBRA'S
PATENT RECORDING THERMOMETER.

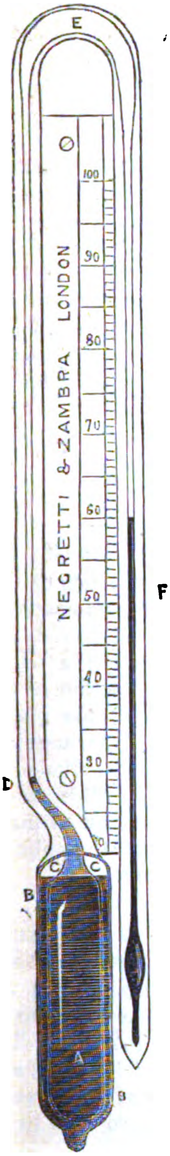


FIG. 102.

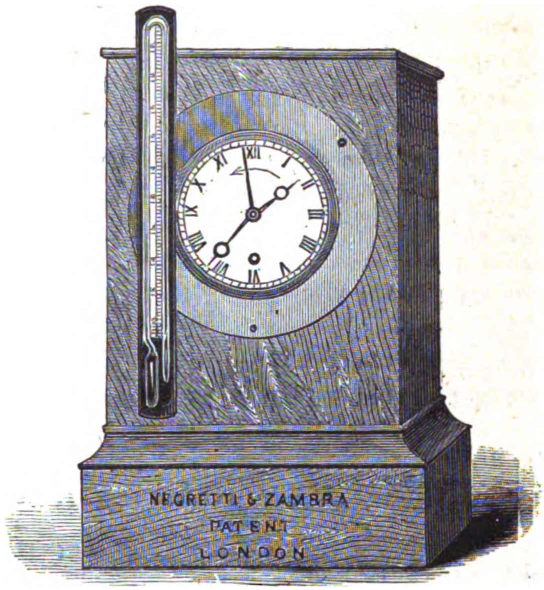


FIG. 103.

142. This Instrument differs from all other Registering or Recording Thermometers in the following important particulars:—

I. The Thermometer contains only Mercury without any admixture of Alcohol or other fluid.

II. It has no indices or springs, and its indications are by the column of Mercury only.

III. It can be carried in any position, and cannot possibly be disarranged except by actual breakage.

IV. It will record the exact temperature at any given hour of the day or night.

Negretti and Zambra's Recording Thermometer in shape is like a syphon with parallel legs, having a continuous communication, as seen in the annexed figure, which is nearly the actual size of the tube. The scale with the Thermometer is pivoted on a centre, and attached in a perpendicular position to a simple clock movement, by which, at any desired moment, the instrument turns once upon its centre, first bulb uppermost, and afterwards bulb downwards. This causes the mercury, which was in the left-hand column, first to pass into the dilated syphon bend E at the top, and thence into the right-hand tube F, where it remains, indicating on a graduated scale the exact temperature at the time it was turned over.

Fig. 102, shows the position of the mercury *after* the Thermometer has been thus turned on its centre. A B is the bulb; D is a small glass plug on the principle of Negretti and Zambra's Patent Maximum Thermometer, which cuts off, in the moment of turning, the mercury in the tube from that of the bulb, thereby ensuring that none but the mercury in the tube can be transferred into the indicating column; E is an enlargement made in the bend so as to enable the mercury to pass quickly from one tube to another in revolving; and F is the indicating tube or Thermometer proper. In its action, as soon as the Thermometer is put in motion, and immediately the tube has acquired a slightly oblique position, the mercury breaks off at the point D, runs into the curved and enlarged portion E, and eventually falls into the indicating tube F, when the tube resumes its original perpendicular position.

143. **Negretti and Zambra's Patent Atmospheric Recording Thermometer,** (fig. 103). For any hour determined upon, the clock carrying the Thermometer is set (similar to an alarum clock), and when the hands arrive at this point of time, the movement of the clock releases a catch or detent, and the Thermometer is revolved, when the mercury will pass from the right hand tube to that on the left, recording the temperature of the air for that exact moment in a similar manner to the Recording Hygrometer, No. 65†, and as described in the previous page. These Thermometers will be found a most important addition to our Meteorological Instruments, and no slight boon to observers in many parts of the world who are engaged in taking simultaneous observations with our own at fixed hours.

Price, as fig. 103 £4 4 0

NEGRETTI AND ZAMBRA'S PATENT APPARATUS FOR RECORDING HOURLY TEMPERATURES.

144. Having explained the action of the Thermometer, we now describe the details of the apparatus shown in fig. 104. It will be seen that this consists of two parts—viz., a clock, and the frame or stand mounted with eight Thermometers.* It is important to note that in this apparatus the *clock only* need be sheltered, and indoors, the movement being transmitted to the recording apparatus by the rod B at the side of the clock to any convenient distance from it. By the action of the clock this rod is moved along horizontally, and by means of certain catches placed at intervals upon it, releases a spring or detent, and allows the first Thermometer to be turned round by the action of a weight and chain attached to a cylinder or drum upon the centre axis, to which each Thermometer is attached. This movement, which takes place at intervals of one hour, causes each Thermometer to make a complete revolution, and transfers the mercury from one side of the tube to the other seriatim, indicating the temperature at that precise moment.

Resetting a Thermometer is simply performed by turning it slowly forward, at the same time tapping it until all the mercury has passed to the left hand tube, and the chain by which the weight is suspended is wound up again upon the cylinder, the detent dropping into the notch, so that the Thermometer is maintained in a vertical position until the spring or catch is again released. The moving rod is likewise simply pushed back after having performed its work, and by an ingenious contrivance the observer can reset the instrument at any time to within five minutes of the first Thermometer being due to revolve, so that he is not bound to reset the Thermometer at any given moment.

* The number of Thermometers may be more or less as desired, and it is to be noted that the Bulbs of the Thermometers, figs. 65†, 103, 104, do not require the double or protected Bulb as used in our Deep Sea Apparatus.

NEGRETTI AND ZAMBRA'S PATENT APPARATUS FOR RECORDING HOURLY TEMPERATURES.

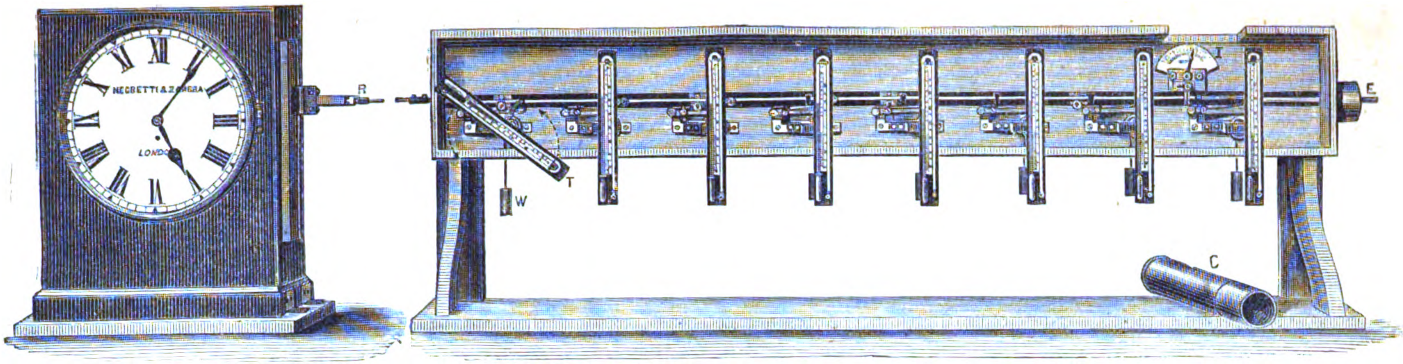


FIG. 104.

Description of fig. 104. On the left hand of the engraving is seen the Clock, and at the side of it is shewn the rod R, by which movement is conveyed to the recording apparatus placed externally wherever the temperature is to be ascertained and recorded.

In this instrument there are eight Thermometers: at each hour one is revolved by the action of the Clock. In the drawing the first Thermometer T is shewn in the act of turning over—this movement being caused by the descent of the weight W directly the spring or catch is released—this spring being so contrived that when the entire revolution has been completed the Thermometer is arrested and maintained in its original vertical position. This revolution of the Thermometer transfers the mercury from the left hand tube to that on the right hand side of the scale, as previously described. At E, is the end of the moving rod R; and at I is *shewn* the regulating index for shortening the action of the rod R in proportion to the delay which has taken place in *resetting* the apparatus after the last Thermometer has *turned over*. The apparatus when in use is covered and protected by a metal case, the Thermometers only being exposed to the external atmosphere.

Price, as fig. 104, £40 0 0

LIGHTNING CONDUCTORS.

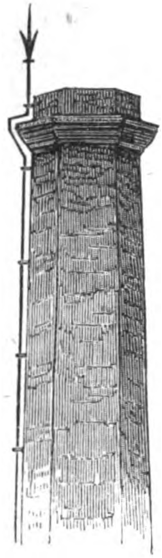


FIG. 105.

145. THE celebrated American philosopher, Franklin, in the year 1749, first discovered the means of averting the destructive and fatal effects of lightning by the use of pointed metallic rods attached to high and exposed buildings, his experiments having proved that the electric fluid will always follow the path of least resistance to the earth.

In confirmation of the value of Lightning Conductors as a safeguard, we quote the following from Sir W. Snow Harris :—

"It appears from the records of the Navy, that the destructive effects of lightning on H. M. ships involved in former years an expenditure of not less than from £6,000 to £10,000 annually. In 200 cases only, 300 seamen were either killed or hurt, and above 100 large masts valued at the time at from £1,000 to £1,200 each entirely ruined. Between 1810 and 1815, 35 sail of the line, 35 frigates and smaller vessels were completely disabled.

" Since the system of Lightning Conductors has been fully carried out in all H. M. ships, it appears damage by lightning has positively vanished from the records of the Navy."

Lightning Conductors should be pointed at the top, and extend a few feet above the highest point of the building or mast. They are best made of *Solid Copper Rods* or Copper Bands, of sufficient diameter and thickness to convey the discharge without melting. Wire rope of copper is now much used, owing to its convenient adaptability to uneven surfaces, *but* great care must be taken to have it of sufficient diameter to prevent fusion, and that both solid rods and wire rope should be *perfectly continuous and unbroken throughout the entire length,* and carried down some considerable distance into the earth, which should be moist, or better still, carried down a well some distance beneath the surface of the water, or the conductor should terminate in several branches on a large sheet of stout copper. In large towns these conductors are carried down and connected with the large water pipes. *On no account should Lightning Conductors be connected with Gas pipes; it is exceedingly dangerous.* Where a building is large, *several conductors* should be used and all large and detached masses of metal in the fabric connected together and then united with capacious conductors leading directly from the highest points of the structure to the earth or sea. In applying such conductors to ships, each mast should have its own conductor, of sufficient size, permanently fixed, and connected with bands of stout copper passing through the sides of the ship under the deck beams, and with the large bolts leading through the keels and keelson to the water including in the circuit all the principal masses of metal used in the construction of the vessel.

It is of the *utmost importance,* that Lightning Conductors be periodically examined to see that they are in perfect condition, as any defects in continuity of the metal rod or wire may lead to serious results. Several instances of most destructive damage both to buildings and ships having lately occurred, arising from defective conductors, we cannot too strongly urge the attention to this caution.

LIGHTNING CONDUCTORS AND FITTINGS.

FIG. 107.

FIG. 106.

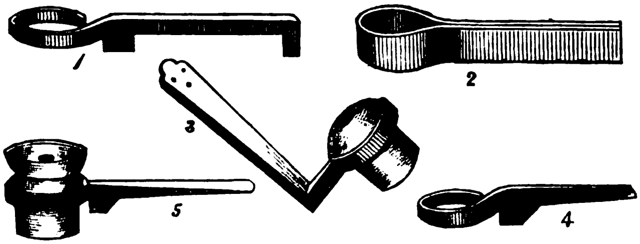


FIG. 108.

Plain Point Solid Copper Lightning Conductor, fig. 106 Elevating Rod and Coupling, 4 feet 6 in. long, with Copper Clips or Holdfasts. No Insulators or Tightening screws. 12s. 6d. and 18s. 6d.

Copper Wire Rope, $\frac{5}{16}$ths diameter, price, per foot 1s. 6d.
Ditto $\frac{3}{8}$ths „ „ „ 1s. 8d.

Solid Copper Points, with three Attractors, Copper Elevating Tube, 5 feet long, and Coupling insulated in Gutta Percha, fig. 107 . . . . per set £1 16 0

If the Points are wished tipped with Platinum, there will be an extra charge, according to weight.

Galvanised Iron Holdfast, to build in, No. 1, fig. 108. per doz. 9s. 6d.
Ditto to Drive, No. 4 per doz. 9s. 6d.
Ditto Ditto for passing along slated roof, No. 3 per doz. 11s. 6d.
Ditto Ditto extra strong, for supporting Rod and Straining Bolt, . . . No. 2 per doz. 9s. 6d.

Copper Elevating Rod, No. 6, showing Holdfast and glass Insulator, to steady the same.

Straining Bolt, No. 7. with Glass Insulator and holdfast complete, insulated with Gutta Percha. Can be adjusted on any part of the rope. No pins or rivets required . . . . per set 10s. 6d.

Tension Bolt, for tightening and straightening the wire of a simple form . . . . 7s. 6d.

Glass Insulators annealed with lock nibs per doz. 10s. and 14s.

Gun Metal Holdfasts, at per dozen extra. . 4s. 6d.

Solid Copper Wire Rope, $\frac{5}{8}$ths inch diameter.
Price per 100 feet £6 10 0
Ditto Ditto $\frac{1}{2}$inch diameter.
Price per 100 feet £5 0 0
Ditto Ditto $\frac{3}{8}$ths inch diameter.
Price per 100 feet £3 16 0

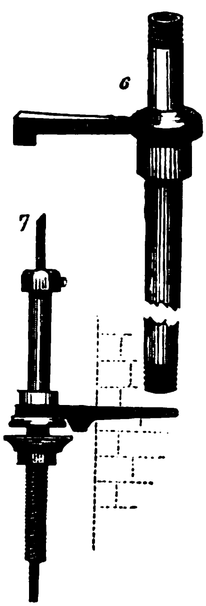


FIG. 109,

NOTE.—The prices for Copper goods varies according to the market value of the metal. As before stated, Platinum Points are variable in price, according to their size and weight. At a small increase of cost the Points can be strongly gilt.

Estimates given for fitting up Lightning Conductors, either with Copper Wire Rope, Solid Copper Rod or Bands.

ESTIMATES FOR SETS OF METEOROLOGICAL APPARATUS.

146. The Meteorological Congress of Vienna, recognising three classes of Observing Stations, we subjoin estimates for Sets of Meteorological Instruments suited to their requirements.

No. 1.—For an Observatory or Station of the First Order.

In which independent meteorological observations are conducted, of the greatest precision, either by hourly readings or with the use of Self-Recording Apparatus.

One Large Observatory Standard Barometer, No. 8 or 9.
One Independent Standard Thermometer, No. 28
One Negretti and Zambra's Patent Standard Maximum Registering Thermometer, No. 34.
One Negretti and Zambra's Patent Standard Maximum Thermometer,—
Exposed Black Bulb, No. 50.
One Ditto Ditto Bright Bulb, No. 50.
One Negretti and Zambra's Improved Patent Maximum Thermometer, in Vacuum, with Test Gauge, No. 37. With Stand for ditto, No. 65.*
One Negretti and Zambra's Standard Minimum Thermometer, No. 38.
One Ditto Ditto Ditto Mercurial, No. 44.
One Ditto Ditto Standard Terrestrial Radiation Thermometer, No. 39.
One Standard Wet and Dry Bulb Hygrometer, No. 62.
One Stevenson's Thermometer and Hygrometer Screen, No. 77.
One Glaisher's Rain Gauge, the New Pattern, complete, Copper, No. 70.
Two Extra Graduated Measures for above.
A Series of Thermometers for Earth Temperatures at varying depths, No. 39.
One Negretti and Zambra's Maximum Thermometers, for Earth or Springs, No. 45.
One Gold Leaf Electrometer, No. 95 or No. 96.
One Anemometer, with two recording Dials, No. 90.
Recording Mercurial Barometer, No. 24.
Recording Thermograph, as page 101.
Recording Hygrometer, No. 65†.
Recording Anemometer and Rain Gauge, No. 92.

Cost for the whole of above verified, £330 to £450.

In first class Observatories it is advisable to have duplicate instruments, where there is any liability of fracture, to avoid breaking off the continuity of the recorded observations.

The No. 1 Set of Meteorological Apparatus can be much extended if it be desired, to make comparative or experimental observations.

No. 2.—Estimate for a Meteorological Observatory of the Second Order.

One Standard Barometer, No. 4.
One Negretti and Zambra's Patent Standard Maximum Thermometer, No. 34.
One Ditto Ditto Standard Minimum Thermometer, No. 38.
One Solar Radiation Thermometer in Vacuo, with Negretti and Zambra's Improved Test Gauge, No. 37.

One Solar Radiation Thermometer, with Exposed Bulb, No. 35.
One Terrestial Radiation Thermometer, No. 39.
One Glaisher's Rain Gauge, Copper, complete, No. 68.
One Anemometer, with two dials, No. 90.
One Wet and Dry Bulb Hygrometer, No. 62.
One Stevenson's Thermometer and Hygrometer Stand, No. 77.

Cost for the above Set of Apparatus, £22 to £25.

No. 2 Set of Apparatus is strongly recommended to *private observers*, where complete and regular observations are taken of Barometric Pressure, Temperature, Humidity, Rain, Wind, and Electrical phenomena. The series can be reduced to form a *Third Class* set at £12 12s., where only a few of the more important meteorological observations are taken, or other instruments can be added to meet the requirements of the observer.

It will be as well to note here that all observations should be made *punctually at fixed hours.* The Meteorological Office recommend that, at Observing Stations of the second order, observations be made *at least* twice a day, at homonymous* hours, for which 9 a.m. and 9 p.m. (local time), have been most generally approved of. In *unsettled weather* occasional observations should be made of any special meteorological facts that may occur.

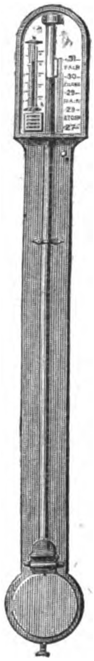
VERIFICATION OF STANDARD METEOROLOGICAL INSTRUMENTS.

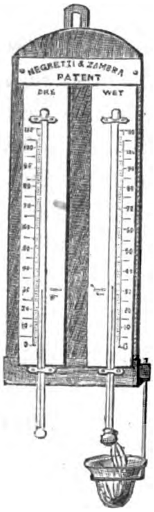
147. The Kew Committee of the Royal Society undertaking the testing and verification of Meteorological Instruments by their Standards, Negretti and Zambra subjoin a list of the charges. At the same time, Negretti and Zambra would observe that, having absolute *Standard Instruments* of their own manufacture which have been compared both with Greenwich and Kew Observatory Standards, they are prepared to compare and give certificates with their *own* instruments *free of charge.*

The Kew Committee wish it to be noted that they do not undertake the verification of inferior instruments, such as Barometers mounted on Wood Frames, and Thermometers *not* graduated on the Stem and also that the Superintendent may at his discretion decline to receive instruments he may consider unfit for Scientific observation.

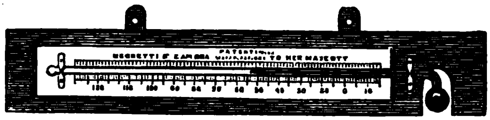
	Each.
Standard Barometers with attached Thermometer	10s. 6d.
Marine Barometers in Metal Mountings	15s. 0d.
Aneroid Barometers for Altitude Measurements compensated	15s. 0d.
Thermometers	2s. 6d. to 5s. 0d.
Rain Gauges	2s. 6d.

* The term "homonymous" signifies hours of the same name, as 9 and 9, or 12 and 12. The most suitable hours are, to a certain extent, to be determined by the locality and climate.

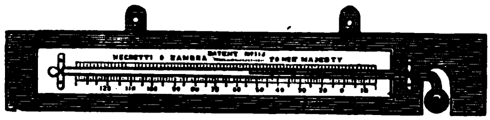




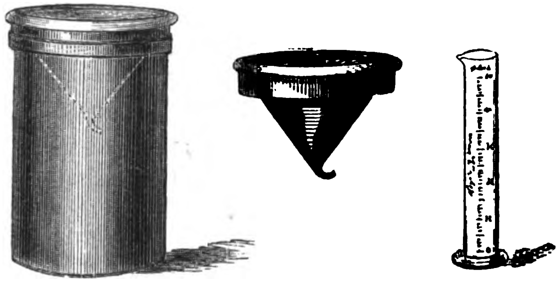
N. & Z.'s Wet and Dry Bulb Hygrometer.



N. & Z.'s Patent Maximum Registering Thermometer.



N. & Z.'s Minimum Registering Thermometer.



N. & Z.'s Glaisher's Standard Rain Gauge.

FIG. 110.

148. NEGRETTI AND ZAMBRA'S FIVE GUINEA SET OF METEOROLOGICAL INSTRUMENTS

consists of a Mercurial Barometer with attached Thermometer having two scales, Registering Maximum Thermometer, Registering Minimum Thermometer, Rain Gauge and Graduated Measure, and a Wet and Dry Bulb Hygrometer, fig. 110.

The whole of these instruments are very carefully manufactured and tested to ensure sufficient accuracy for ordinary observers at a very moderate price. One important feature in this set is that the various instruments will travel securely, as, although they are not strictly a standard set, they have all Negretti and Zambra's improvements and patents adapted to them, and are compared and verified by Negretti and Zambra, and, if desired, certificates given.

This set of meteorological instruments can be modified, and extended, to meet the wishes of our customers. Descriptive particulars of the construction and use of these instruments will be found in the previous pages, or in Negretti and Zambra's *Treatise on Meteorological Instruments.* See next page.

METEOROLOGICAL PUBLICATIONS.

A TREATISE ON METEOROLOGICAL INSTRUMENTS, Explanatory of their Scientific Principles, Method of Construction, and Practical Utility, by NEGRETTI AND ZAMBRA. Numerous Tables of Reference in connection with Meteorology. Illustrated with 100 Engravings. Price 5s.

HYGROMETRICAL TABLES, Adapted to the use of Negretti and Zambra's Wet and Dry Bulb Thermometer, by J. GLAISHER, Esq., F.R.S. Price 2s. 6d.

TABLES OF THE CORRECTIONS FOR TEMPERATURES, to reduce observations to the 32° Fahrenheit, for Barometers with brass scales extending to the top of the mercurial column. By J. GLAISHER, Esq., F.R.S. Price 1s. 6d.

TABLE OF THE DIURNAL RANGE OF THE BAROMETER. By JAMES GLAISHER, Esq., F.R.S. New Edition. Price 1s. 6d.

TABLES FOR CALCULATION OF HEIGHTS from Observations on the Boiling Point of Water, arranged for use with Negretti and Zambra's Boiling Point or Hypsometric Apparatus. By the late Mr. WELCH, of the Kew Observatory. Price 1s.

BAROMETER MANUAL, OR HOW TO FORETELL WEATHER, compiled by Admiral FITZROY, F.R.S., &c., for the Board of Trade. Published by NEGRETTI AND ZAMBRA with permission. Price 6d.

TABLE SHOWING THE READINGS OF THE BAROMETER, Corresponding Numbers of Elevation in English Feet, and of Readings of Aneroid or Corrected Barometer in English Inches; (the Mean of Atmospheric Temperatures being 50° Fahrenheit). Kindly compiled by the Astronomer Royal for NEGRETTI and ZAMBRA. Price 6d.

L. F. KÆMTZS' COMPLETE COURSE OF METEOROLOGY. Translated by C. V. WALKER, Esq. Price 12s. 6d.

POCKET METEOROLOGICAL REGISTER AND NOTE BOOK. (Strachan's) with Diagrams for exhibiting the Fluctuations of the Barometer, Thermometer and Hygrometer. NEGRETTI AND ZAMBRA. Price 2s. 6d.

WEATHER CASTS AND STORM PREVISION. By R. STRACHAN, F.M.S. Price 1s.

SYMONS', G. J. British Rainfall (published annually since 1865). each 5s.
Monthly Meteorological Magazine, Vols. 1 to VI. each 5s.
Rain; How, When, Where, and Why it is measured. 2s.

SYMONS', G. J. Meteorological Register, with Instructions, for one year, 2s.
" " " for five years, 7s. 6d.

SYMONS', G. J. Blank Diagrams for Barometer and Thermometer, for one year, 1s.

SYMONS', G. J. Blank Rainfall Register for one year, 3d.

NEGRETTI AND ZAMBRA'S BAROMETER AND THERMOMETER CHARTS.

"THE DAILY TELEGRAPH" BAROMETER CHART.

[FROM NEGRETTI AND ZAMBRA'S SELF-REGISTERING BAROMETER.]

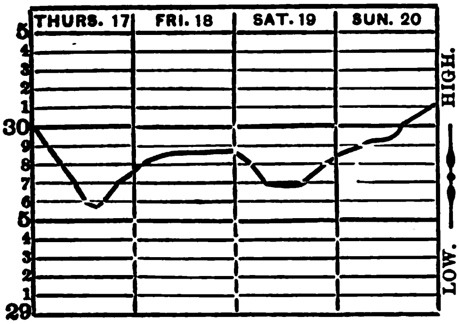


FIG. 111.

The above chart represents the movement of the barometer, corrected for sea-level and reduced to 32° F., during the last four days ending midnight, May 20-21.

GENERAL REMARKS.—A return of a north-easterly wind, accompanied by occasional showers of drizzling rain, caused the weather yesterday to be very bleak and unseasonable. The barometer rose throughout the day, the reading at midnight being 30·11.

DOVER.—Fine and cold; wind S.W.; sea rough; bar. steady.

The method of keeping these Barometer and Thermometer Charts is well shewn in our diagram, (fig. 111). This is an *actual reprint* from a Chart published in the *Daily Telegraph* newspaper, of the morning of May 21st, 1877.

By a most ingenious arrangement of fixed and moveable types *invented by Negretti and Zambra,* the rise and fall of the mercury in the Barometer tube (as indicated by Negretti and Zambra's Recording Barometer) is published every morning in the *Daily Telegraph,* the diagram exhibiting the indications of the Barometer for the previous four days and to within a few hours of going to press.

Modifications of this method of publishing a daily Barometrical record have been carried out by the firm for several other daily papers, and in varying forms are now used by almost every daily and weekly newspaper.

149. CHARTS FOR KEEPING A RECORD OF THE VARIATIONS OF THE BAROMETER AND THERMOMETER.

Each sheet is ruled and figured for one month's observations; twelve of these sheets are neatly mounted on a card, so that when one month's readings are ended the sheet can be removed by cutting round the edge with a sharp knife, and a fresh sheet will be exposed. These records form a most interesting and valuable reference for comparing present and past weather.

Price of each pad of 12 sheets, for Barometer,			2s. 6d.
Ditto	ditto	for Thermometer,	2s. 6d.
Combined	ditto	for Barometer, Thermometer, Hygrometer, Rainfall, &c.,	2s. 6d.

These Pads of Charts can be forwarded by Book Post for Fourpence.

Ruled Charts or Diagrams for the Recording Barometer, fig. 24, and Recording Aneroid Barometer, fig. 26 . . . . price, per hundred £1 5 0

Ditto Ditto, for Recording Anemometers, figs. 92 and 93 „ „ 1 5 0

Ditto Ditto, Ditto, Tide Gauges, figs. 100 and 101 „ „ 1 1 0

DIAL AND PEDIMENT BAROMETERS.

The ordinary household Barometers or Weather Glasses are constructed in two forms, viz., the Wheel or Dial Barometer, and the Pediment or Upright Barometer. The former reading by an extended circular scale, and the latter from the actual mercurial column.

The Dial Barometer is mounted with the syphon form of tube as shown in our diagram, the shorter limb of the syphon being about six or eight inches long. This obviates the use of a cistern, for with sufficient mercury in the short tube, that in the longer one will be balanced at a varying height in accordance with the increased or diminished pressure of the atmosphere.

This form of Barometer was first constructed by the celebrated philosopher Dr. Hook; the principal advantage of the dial arrangement is that by it a small movement in the mercurial column is magnified and made very apparent, a tenth of an inch rise or fall being represented by the index moving over nearly one inch on the dial, this enables the unscientific observer to notice quickly if the Barometer be rising or falling and estimate the probability of fine or wet weather.

On the top of the mercury in the short limb of the tube is suspended a glass float, by a silk cord which passes two or three times round a small brass wheel or pulley; at the other end of this silk cord is placed a counterpoising glass weight, moving freely in a second tube placed at the side of the syphon for the purpose of steadying the weight.

The axis of the pulley is carried through the wood frame of the Barometer to the front of the instrument where the movement of the mercury is shown by a light index hand attached to it, traversing a divided dial.

As the mercury in the Barometer tube rises, the silk cord descends, causing the index hand to move to the right; on the contrary, as the mercury falls the index will be carried in the reverse direction to the left.

The graduations on the dial represent the actual inches of a Standard Barometer scale, extended as previously described, giving what is termed a very open scale.

If the mercury rises half an inch in the long tube it will fall half an inch in the shorter one. Therefore, as the mercury rises half an inch in the one tube and falls half an inch in the other, the length of the barometrical column has increased one inch,—but the movement has only been through half an inch —this amount of movement transferred to the pulley causes the index hand to indicate an inch movement on the dial, say from twenty-nine to thirty inches.

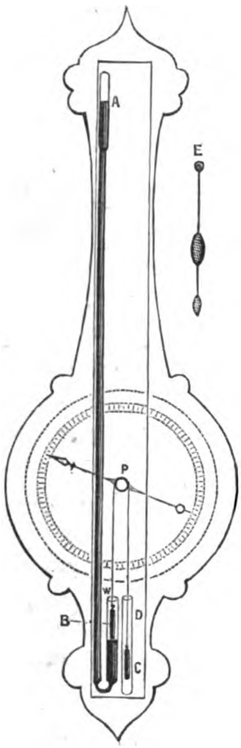


FIG. 112.

150. Our engraving (fig. 112) exhibits the general internal arrangement of the Dial Barometer.

A B is the mercurial syphon tube, and at W is seen the glass weight cr float attached to a silk cord. This weight floats upon the surface of the mercury rising or falling in the tube in accordance with the movement of the mercurial column; by the side of the syphon is a second guide tube D for the counter-poise weight C, at P is shown the pulley over which the silk cord passes giving movement to the index hand over the Dial as previously described.

At the side of the diagram we show a wire plug, E, used for making these barometers portable for travelling or exportation. It is simply a stiff wire covered with cotton throughout its whole length, and as will be seen in the drawing, it has sufficient cotton wound round the lower end to fit the mercurial tube tightly at *two* points.

TO MAKE THE DIAL BAROMETER PORTABLE.

151. By inclining the Barometer the mercury is caused to fill the tube *entirely*, the float is then withdrawn from the mercurial tube W, (carefully avoiding disturbing the silk cords,—most of Negretti and Zambra's Barometers are now fitted with a brass clamp to secure the cords) and then the plug E is forced slowly down the tube until the mercury is perfectly secured. The glass float being placed at the side of the syphon and secured with a little soft packing carefully placed round it and the glass tubes, the instrument is now made portable or secure for transit.

We need hardly point out that the Dial Barometer must not be regarded as an instrument of precision, but simply as a weather indicator or household barometer.

Instructions for setting the Barometer in action will be sent with each instrument if it has been made portable.

The absolute height of the Barometer, at any moment, does not always indicate present weather. The rise or fall of the mercurial column supplies the information of coming weather or change.

A rapid rise or fall, indicates changeable and unsettled weather.

A falling Barometer and rising Thermometer, are commonly and quickly followed by rain.

"The longer the time between the signs and the change they foretell, the longer will the altered weather last; and the shorter between the warning and the change, the shorter the continuance of the changed weather."

"A fall, with a low Thermometer, foretells Snow."

When the Barometer falls with the wind S.E., it is generally followed by long continued Rains.

A rapid fall of the Barometer is usually followed by much Wind as well as Rain.

For further hints *How to fortell the Weather* see N. and Z.'s *Barometer Manual*, compiled for them by Admiral FITZ-ROY. Price post free, Sixpence.

DIAL BAROMETERS, OR WEATHER GLASSES.

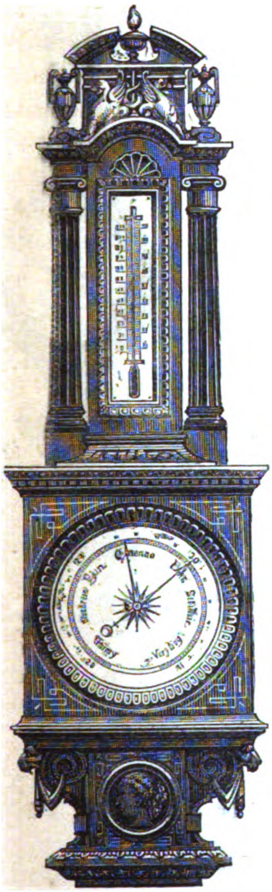


FIG. 164.

FIG. 163*.

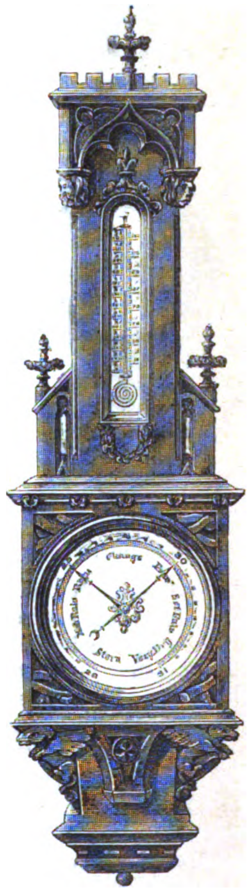


FIG. 164*.

BAROMETERS being now mounted in so many varied styles, both plain and carved, the following are given as a few specimens of those most in demand. Large stocks of these instruments are always kept at all of NEGRETTI and ZAMBRA's establishments of most of the patterns shown in the engravings. Barometers supplied to order of any style of Architecture, to correspond with the furniture of Libraries, Halls, &c.

NOTE.—*The marginal Nos. from this page will correspond with those of the wood-cuts.*

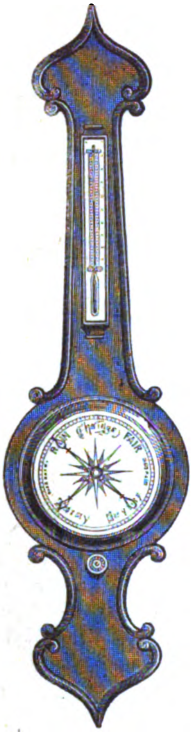


FIG. 158.

FIG. 156.

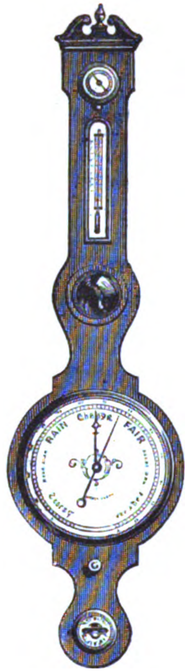


FIG. 155.

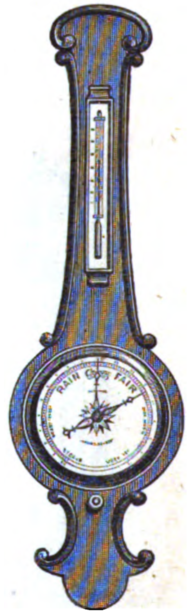


FIG. 158*.

No.	Description	Each. £	s.	d.	Each. £	s.	d.
152	8-inch **Silvered Brass Dial Barometer,** common, mounted in mahogany or rosewood frame, with or without mirror, hygrometer, and level				1	10	0
153	8-inch ditto ditto, square bottom	2	2	0	2	10	0
154	Ditto ditto, superior finish, engraving, and large tube				3	10	0
155	10-inch **Silvered Brass Dial Barometer,** in common mahogany or rosewood frame, with or without mirror, hygrometer, and level (fig. 155)	2	2	0	3	3	0
156	Ditto, Ditto, square bottom (fig. 156)	2	10	0	3	10	0
157	Ditto, Ditto, Extra best both as regards frame, dial, engraving, and tube (figs. 155 or 156)	4	4	0	5	5	0
	12-inch Dial Barometers of the same patterns, from 15s. to £1 5s. extra.						
158	8-inch **Scroll Pattern Dial Barometer,** best mounted mahogany, oak, walnut, or rosewood frames, silvered brass dial, with thermometer (figs. 158 or 158*) . .	3	3	0	4	4	0
	10 and 12-inch Scroll Pattern Barometers, 20s. to 50s. extra.						
159	8-inch **Dial Barometer,** with ornamental figures, letters, and divisions on PATENT ENAMELLED GLASS DIAL (figs. 158 or 158*)				5	5	0
160	8-inch **Dial Barometer,** rosewood frame inlaid with PEARL or METAL, with silvered brass dial				8	8	0
161	10-inch ditto, best rosewood frame inlaid with PEARL or METAL, the dial of silvered brass, with thermometer, superior engraving and finish (fig. 161)				12	12	0
	12 and 14-inch Dial Barometers ditto, at proportionate prices.						

FIG. 161.

FIG. 162.

FIG. 163.

No.	Description	Each. £	s.	d.
162	14-inch **Dial Barometer,** best rosewood frame inlaid with PEARL or METAL, the dial of silvered brass, and an eight-day **Clock** fitted in the frame, thermometer, &c. (fig. 162)	25	0	0
163	8 and 10-inch **Dial Barometers,** plain carved, in solid oak, mahogany rosewood, or walnut frame, double basil ring, and polished-edge plate glass, of the very best construction and superior engraving, shape as figs. 163 and 163* . . . . . £5 5s. £6 6s.	8	8	0
164	**Dial Barometers,** 10, 12, and 14-inch, of the very best construction, in richly carved solid frames of Gothic, Mediæval, Elizabethan, Egyptian, or other designs, in oak, mahogany, or walnut-wood (figs 164 and 164*) . . . . . . £10 10s. £16 16s. to	25	0	0

Suitable for Club-houses, Mansions, &c.

N.B.—DIAL BAROMETERS required for transmission to distant parts, such as India, or the Colonies, should be ordered *expressly*, as in that case they will be rendered portable by plugging the tube as described page 112, and shown in diagram fig. 112.

The prices quoted for the more elaborate forms of Dial Barometers are subject to variations dependent upon the amount and quality of the ornamental carving and engraving.

PEDIMENT BAROMETERS.

NEXT to a Standard instrument the Pediment Barometer must be regarded in a scientific point of view as the most accurate form of Barometer, the actual weight or pressure of the atmosphere being exhibited by the varying length of the mercurial column itself, subject to a few corrections that need not be noticed by ordinary observers. At page 2 will be found the general principles of the straight tube or Pediment Barometer.

The cistern of the Pediment Barometer is made of boxwood with sufficient internal area to allow of a fall of at least two-thirds of the mercury contained in the tube when the Barometer is in action without materially interfering with the correctness of the readings. It should also contain sufficient mercury to prevent air passing up into the tube. The bottom of the cistern is formed of flexible leather, so as to admit of the use of a screw to render the Barometer *portable*, as described in the paragraph—Standard Barometer, page 3.

It will be seen that most of these Barometers are furnished with *two* Verniers, or indices. The use of the *second* Vernier is to record on the left hand scale of the instrument the previous reading of the Barometer, and show at a glance any alteration that may have taken place by the difference of the readings of the two Verniers.

In taking a reading or observation by the Pediment Barometer the Vernier carrying the Index Pointer is to be moved gently up or down, until its edge is exactly in a line with the centre of the top of the mercurial column as shown in fig. 5, page 5. If when adjusted the edge of the index is *exactly* in a straight line with, say, the division marked 30, then the height or length of the mercurial is exactly thirty inches. The value of this column is given on pages 2 and 3, also on pages 5 and 6 will be found a description of the use of the Vernier, especially at the foot of page 6, where the Vernier of the ordinary Household Barometer is spoken of as subdividing the inch scale in hundredths.

If the division 1 in the Vernier coincides with the line at 29 inches on the scale, then the reading would be 29·11; if division 2 coincides with the line below that marked 29 inches, then the reading would be 29·12, that is twenty-nine inches and eleven hundreths or twenty-nine inches and twelve hundredths, or it may be read twenty-nine inches one tenth and one hundredth, and so on. The allowance to be made for height of the Station above the sea-level is, as stated by Admiral FitzRoy, as under.

The *average* height of the barometer, in England, at the sea-level, is about 29·94 inches, and the *average* temperature of air is nearly 50 degrees.

Every ten feet of elevation above the sea lowers the Barometer about ten or eleven thousandths of an inch.

Add one-tenth of an inch to the observed height for each hundred feet the Barometer is *above* the mean sea-level. This sea-level should be that of the ocean itself, at mean half-tide, a level which should be the universal standard line of reference.

The Thermometer falls about one degree for each three hundred feet of elevation *above* more than fifty feet from the ground.

PEDIMENT BAROMETERS.

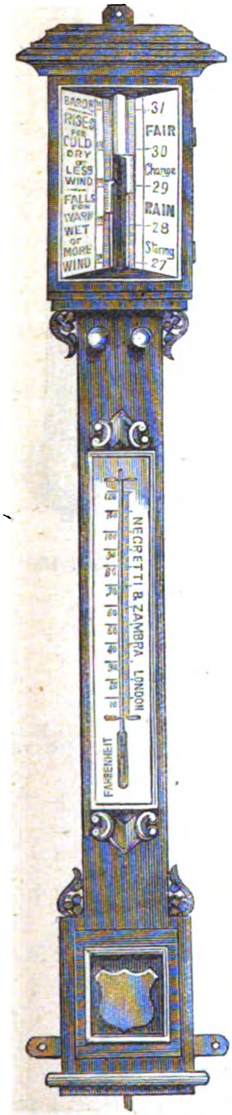


FIG. 173.

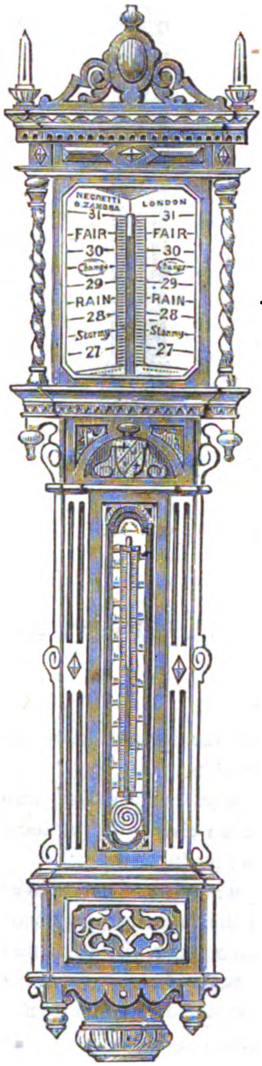


FIG. 174.

FIG. 175.

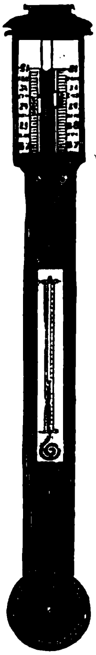


FIG. 169.

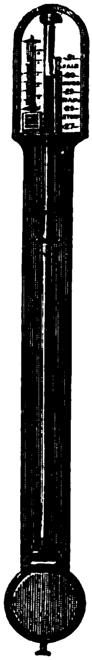


FIG. 166.

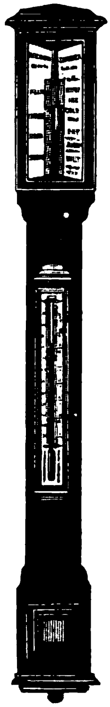


FIG. 170.

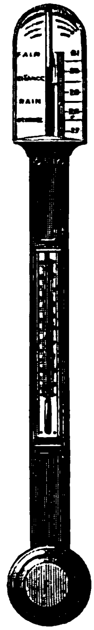


FIG. 168.

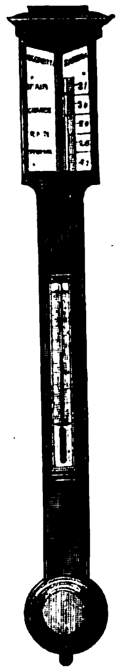


FIG. 169*.

PORTABLE PEDIMENT BAROMETERS.

No.	Description	Each £ s. d.	Each. £ s. d.
165	**Model Barometer,** with vernier and thermometer, also screw, to render it portable		1 1 0
166	**Pediment Barometers,** with ivory scales, thermometer, SLIDING VERNIER, the tube visible throughout the whole length, and portable screw (fig. 166)	2 2 0	2 10 0
167	**Pediment Barometer,** with glass cover over the face, rackwork vernier and thermometer, exposed tube .		2 15 0
168	**Portable Pediment Barometer,** in oak, mahogany, or rosewood frame, the tube covered entirely, rackwork vernier, and a thermometer on the front (fig. 168) .		3 3 0
169	Ditto ditto, with square moulded top, large tube, and one vernier (figs. 169 and 169*)	3 10 0	4 10 0
170	Ditto ditto, with larger tube, double rackwork vernier, ivory scales, with thermometer, in oak, mahogany, walnut, or rosewood frame (fig. 170)	5 5 0	6 6 0

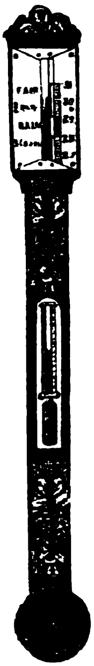


FIG. 171.

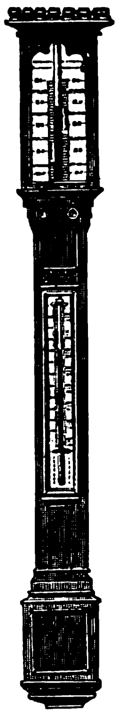


FIG. 172.

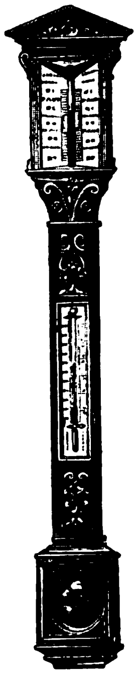


FIG. 172A.

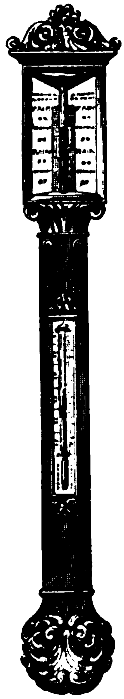


FIG 172B.

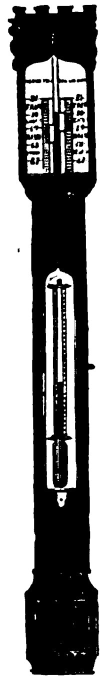


FIG. 172C.

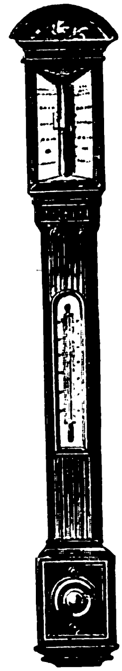


FIG. 172D.

Each £ s. d.

171 **Portable Pediment Rosewood Barometer,** elegantly inlaid with pearl, or metal, thermometer in front, ivory scale, rackwork vernier (fig. 171) 7 7 0

172 **Portable Pediment Barometers,** with two Verniers, best Carved oak, rosewood, walnut, or mahogany frames, of various elegant designs, fitted up in the very best manner (figs. 172 and 172 A, B, C, D). £6 6s £8 8s. 10 10 0

173 **Large Pediment Barometers,** handsomely mounted in oak, walnut, or ebonised frames, the tube of large internal diameter, and the cistern presenting a large area, to insure uniformity in reading, ivory, enamelled glass, or silvered metal scales, with engraved ornamental letters and two verniers (figs 173 and 173*) £8 8s. £10 10s. £12 12s. 15 15 0

174 Ditto ditto, **Ebonised** wood frames with ivory or enamelled glass scales and two verniers very handsomely carved (fig. 174) . . . . £18 18 0 to 26 0 0

Extra large Pediment Barometers, suitable for Public Institutions and Club Houses, designed and made with English or French and English Scales to order.

175 The FITZROY STORM BAROMETER, or FISHERMAN'S and LIFE BOAT STATION BAROMETER, as made by Negretti and Zambra especially for the Board of Trade and Royal Life Boat Institution, to be fixed at all the principal seaports, fishing and life boat stations.

fig. 175. Price, £5 5s.

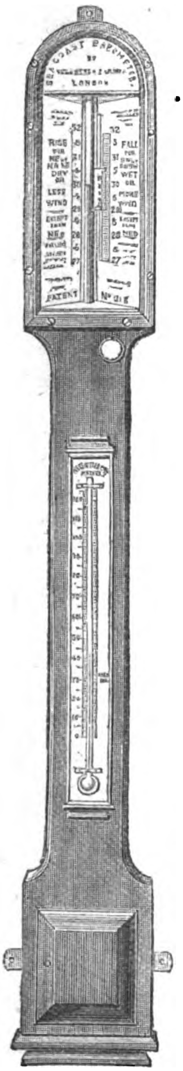


FIG. 175.

This Barometer consists of a tube with very large bore, and an accurate Thermometer, mounted in a solid oak frame, firmly screwed together, with scales and figures, &c., permanently engraved on *Porcelain*, by Negretti and Zambra's patent process, the vernier reading to 100-ths of an inch. It is strongly recommended as a good, sound working instrument, admirably adapted for use in Public Institutions.

Extract from Admiral FitzRoy's Report of the Meteorologic Office of the Board of Trade, 1864 :—

"In my last Report, I stated how highly the Board of Trade 'Fishery' Barometers have been valued on the coasts. They are now eighty in all, specially *lent, under due control and care.* Two only of this number have become slightly defective, and have been exchanged. Not one has been injured in carriage, singular to say, between Cornwall and the Shetland Isles, Ireland and Yorkshire. It may be more readily *estimated* mentally, than accurately proved, to what extent these simple instruments (all reliably made† and tested) have already been the means of saving life and property. Explanatory Manuals and blank forms for diagrams have been extensively circulated among the coasters and fishermen, who are all, now, much influenced by, and very thankful for, the benefits of this act of their Government. Many are the local instances of similar beneficence by individuals—especially the Duke of Northumberland, who has placed no less than fourteen barometers."

Messrs. Negretti and Zambra would specially caution the Public against purchasing cheap and worthless imitations of Admiral FitzRoy's Barometers, as leading to disappointment. Full details both as to the construction and use of the true Fitz-Roy instrument will be found in Negretti and Zambra's Barometer Manual, compiled by Admiral FitzRoy for the Board of Trade; post free, 6d.

175 FitzRoy Barometers in Ornamental Solid, Carved oak, walnut, or mahogany frames, with two verniers**

fig. 173* £6 10s. £8 8s.

Barometers in solid frames, as figs. 173 and 173*, mounted with ivory or enamel glass scales, having the FitzRoy Weather Rules on one side and the ordinary words, Fair, Change, Rain, and Stormy on the other, at the same prices as No. 175** These instruments are very suitable for Public Institutions.

† *By Messrs. Negretti and Zambra.*

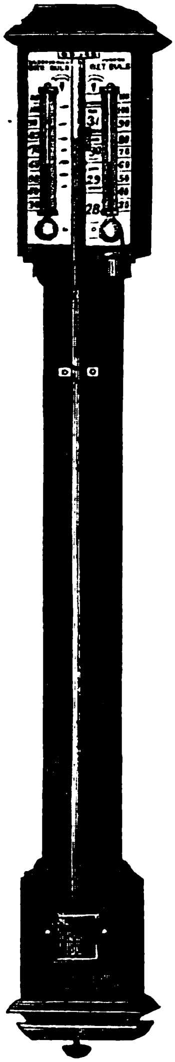


FIG. 176.

176 **Negretti and Zambra's Farmer's Barometer,** for ascertaining the humidity of the atmosphere, the general character of the weather, and the approach of wind or rain. The Farmer's Barometer combines three distinct instruments—the Barometer, the Thermometer, and the Hygrometer, and is equally valuable to the Agriculturist and the Invalid, a differance of 5° to 8° being considered a healthy amount of moisture in the air of dwelling rooms. The action is very simple, and so long as a sufficient supply of water is kept in the cistern, the Hygrometic condition of the atmosphere can be known at any moment.

It is a well-known fact that the Barometer is as much, or even more affected by a change of wind as it is by rain, and the objection raised against a simple Barometer reading, as leaving the observer in doubt whether to expect rain or wind, is entirely removed in the instrument now offered to the Public by the addition of the Hygrometer, an instrument indicating the comparative degree of dryness or dampness of the air;—a most important item in the determination of the coming weather.

Hitherto the use of scientific instruments of this class has been confined to very few observers, and until lately has borne very little fruit. Nevertheless, through the instrumentality of James Glaisher, Esq., F.R.S., as Secretary of the British Meteorological Society, multitudes of observations have been taken with extreme accuracy, and duly registered; and it is from these carefully collected data that we are enabled in a measure to interpret the various changes that we feel and see going on in our atmosphere, and by the aid of well-constructed instruments, are in a position to predict with a great degree of certainty the weather that is likely to prevail from time to time.

At page 54 will be found a table giving the value of Hygrometic readings in a simple form sufficient, for the use of ordinary observers.

The **Farmer's Barometer** as fig. 176 . . . . . £2 10s.
Ditto ditto in Ornamental Mountings £5 5s. £6 6s.

177 **Negretti and Zambra's Miners' Barometer.**—It having been observed, that explosions of gas in mines mostly occur when the Barometer is very low (showing diminished atmospheric pressure), it is important that a good Barometer should be at hand, for observation by the Managers and others. For this purpose Negretti and Zambra make strong and sufficiently accurate Barometers, as fig. 177 at . . £1 1s. £2 2s. £3 3s.

178 **Aneroid Barometers, for Miners' use,** exceedingly convenient and sensitive. with extended scale . . . . £2 10s. £3 10s. £4 4s.

179 **Miner's Pocket Aneroids,** see figs. 204 and pages 18 and 128.
£3 3s. £4 4s. £5 5s.

STANDARD AND MOUNTAIN BAROMETERS (see pages 1 to 11).

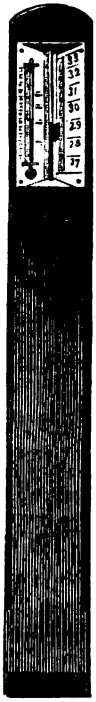


FIG. 177.

FIG. 180.

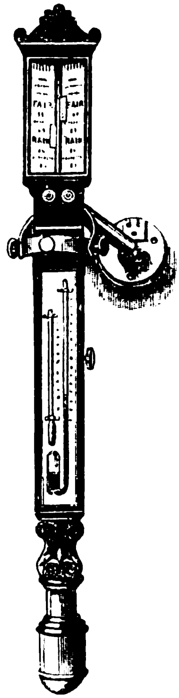


FIG. 184.

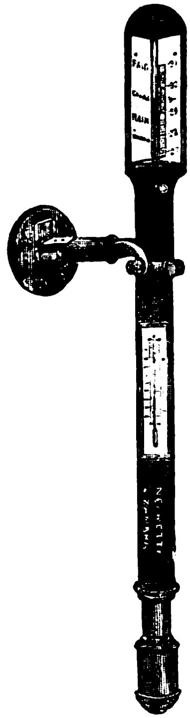


FIG. 183.

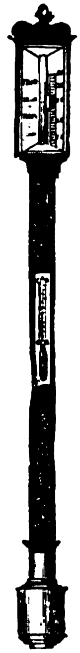


FIG. 182.

MARINE BAROMETERS.

No.	Description	Each. £ s. d.	Each. £ s. d.
180	**Marine Barometer,** plain mahogany frame, with ivory scales, sliding vernier, thermometer, and brass arm jimbal, for suspension, complete (fig. 180) . . .	2 2 0	2 10 0
181	**Marine Barometer,** round, moulded, or carved top, with rack-work to vernier, thermometer, capillary tube to prevent the ingress of air into the column, even during the most violent oscillations of a storm, brass jimbal, &c.		3 3 0
182	Ditto ditto, with brass jimbal, in **Carved** frame, inlaid with pearl (fig. 182)		4 4 0
183	**Marine Barometer,** best mounted as (fig. 183) . .		5 5 0
184	**Marine Barometer** best, with SYMPIESOMETER in front; the sympiesometer constructed and laid off with the greatest accuracy by actual experiments, brass jimbal, &c. (fig. 184)		6 6 0

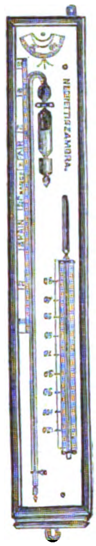


FIG. 188.

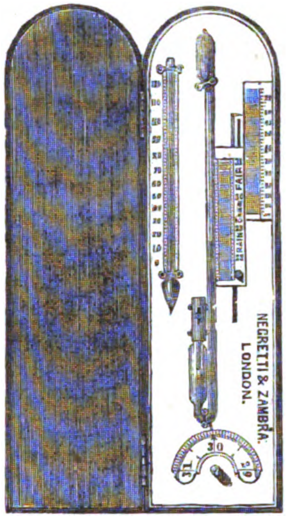


FIG. 189.

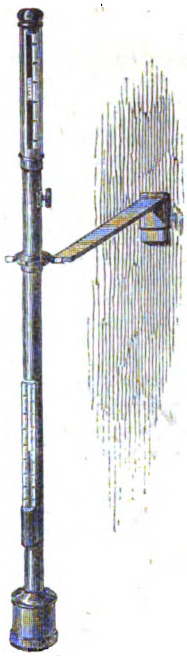


FIG. 185.

FIG. 186.

185 BOARD OF TRADE STANDARD, OR KEW MARINE BAROMETER,

bronzed frame with iron cistern, as made by Negretti and Zambra for Her Majesty's Goverment, and recommended by the Brussels Conference for Marine Meteorological observations, mounted with the most recent improvements to prevent the mercury pumping in bad weather (fig. 185) £4 4 0

In travelling case, with lock and key.

186 FITZROY'S MARINE GUN BAROMETER,

constructed by Messrs. Negretti and Zambra, under the *immediate superintendence and named by permission* of the Admiral, for the special use of Her Majesty's Navy, with vulcanised India-rubber packing, &c., to prevent concussion and breakage, caused by gun firing. Packed in case (fig. 186) £5 10 0

Extra tube for ditto . . . 1 15 0

Admiral FitzRoy writes :—

"This Marine Barometer, for Her Majesty's service, is adapted to *general* purposes.

"It differs from barometers hitherto made in points of detail, rather than principle:—1. The glass tube is packed with vulcanised india-rubber, which checks vibration from concussion, but does not hold it rigidly, or prevent expansion. 2. It does not oscillate (or pump), though extremely sensitive. The scale is porcelain, *very legible*, and not liable to change. 4. There is no iron anywhere (*to rust*). 5. Every part can be unscrewed, examined, or cleaned, by any careful person. 6. There is a *spare* tube, fixed in a cistern filled with boiled mercury, and *marked* for adjustment in this, or *any similar* instrument.

"These barometers are graduated to hundredths, and they will be found accurate to *that* degree, namely, the second decimal of an inch."

Trials of the FitzRoy Marine Barometer under Fire of Guns.—Some of the first barometers made by Messrs. Negretti and Zambra on Admiral FitzRoy's principle were severely tried under the heaviest naval gun firing, on board H.M.S. *Excellent;* and under all the circumstances, they withstood the concussion. The purpose of the trials was "to ascertain whether the *vulcanised India-rubber packing* round the glass tube of a *new Marine Barometer* did check the vibration caused by firing, and whether guns might be fired close to these instruments without causing injury to them." In the first and second series of experiments, a Marine Barometer on Admiral FitzRoy's plan was tried against a Marine Barometer on the Kew principle, both instruments being new, and treated in all respects similarly. They were "hung over the gun, under the gun, and by the side of the gun, —the latter both inside and outside a bulkhead; in fact, in all ways that they would be tried in action with the bulkheads cleared away." The result was that the Kew barometer was broken and rendered useless, while the new pattern barometer was not injured in the least. In a third series of experiments, Mr. Negretti being present, five of the new pattern barometers were subjected to the concussion produced by firing a 68-pounder gun with shot, and 16 lbs. charge of powder. They were suspended from a beam immediately under the gun, then from a beam immediately over the gun, and finally they were suspended by the arm to the bulkhead, at the distance of only 3 ft. 6 in. from the axis of the gun; and the result was, according to the official report, "that all these barometers, however suspended, would stand, without the slightest injury, the most severe concussion that they would ever be likely to experience in any sea-going man-of-war." These trials were conducted under the superintendence of Captain Hewlett, C.B., and the guns were fired in the course of his *usual* instructions. His reports to Admiral FitzRoy, giving all the particulars of the trials, are published in the "Ninth Number of *Meteorological Papers*," issued by the Board of Trade.*

* With reference to these barometers, we have received the subjoined testimonial, with permission to use as we please.

"*Meteorologic Office*, 12*th June*, 1863.

"MESSRS. NEGRETTI AND ZAMBRA,

"The barometers which you have lately supplied to Her Majesty's ships through this Office are much approved, being good for general service, afloat or on land.

"(Signed) R. FITZROY."

SYMPIESOMETERS.

Previous to the invention of the Aneroid Barometer, the Sympiesometer, from its extreme sensibility and convenient size, was much used for marine observations; but owing to its liability to be put out of adjustment in transit, it is now rarely used except as an instrument of comparison.

Being partly acted upon by the pressure and partly by the temperature of the air, its correct name would be a Thermo-Barometer.

Directions for using the Sympiesometer.—It should be always carried top upwards, to prevent the air mechanically mixing with the liquid. Care should also be taken to screen it from the heat of the sun or cabin fire.

To ascertain the atmospheric pressure by the sympiesometer, note first, the temperature of the mercurial thermometer; secondly, adjust the pointer of the pressure scale to the same degree of temperature on the scale of the air column; thirdly, read the height of the liquid on the sliding scale, the divisions and figures representing the inches and tenths of the Barometer scale.

		£ s. d.	£ s. d.
187	**Sympiesometer,** in rosewood or mahogany frames, with registering index and plate glass front	2 10 0	3 3 0
188	Ditto ditto, with rackwork movement, large size and best make (fig. 188)		4 10 0
189	**Pocket Sympiesometer,** suitable for travelling, and taking altitudes, or mountain service in leather hinged case (fig. 189)		3 15 0
190	Ditto ditto in leather case with strap for **Mountain service.** (almost entirely superseded by the Aneroid Barometer)		4 4 0

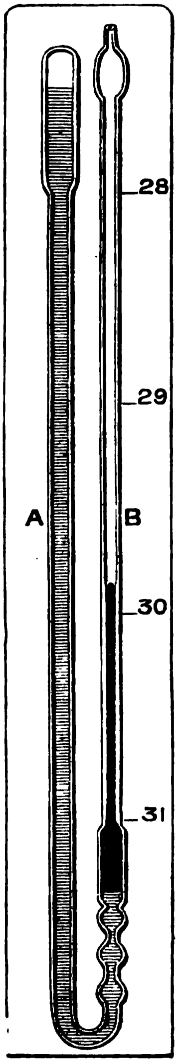


FIG. 191.

191. **The Long Range or Open Scale Barometer.** (Fig. 191.) This instrument consists of a mercurial tube on the syphon principle; one side of the syphon, A, or closed end, being about 33½ inches long, and the other only a few inches in length. To this short end, or leg, is joined a length of glass tubing, B, of a much smaller (internal) diameter; both legs being of equal length, the smaller tube is filled with a fluid many times lighter in specific gravity than mercury; the rising and falling of the mercurial column in the large tube having a lighter fluid to balance, and that dispersed over a larger space by reason of the difference in the diameter of the two tubes a longer range is obtained, due both to the unequal capacity of the two tubes and the difference in the specific gravity of the mercury and the second fluid employed. The range of these barometers is from six to ten inches to the inch of the ordinary mercurial barometer. 1-100th of an inch can easily be observed without the use of a vernier. It is a most interesting instrument as from the extremely extended scale the slightest variation is plainly visible. In the engraving (fig. 191), the Long Range Barometer is shown in section. The actual size and form is about that of an ordinary Pediment Barometer. Best mounted £3 3 0

This form of Long Range Barometer is not of any scientific value, but is merely a curiosity as a Weather Indicator. It is somewhat difficult to make portable for transit.

192 Another form of Extended Range Barometer was invented and made by M. Amontons in 1695, and named by him the Pendent Barometer. It is a Mercurial Barometer, the upper half of the tube (the indicating portion) being of *smaller* internal diameter than the lower half. By this arrangement, a most extended range of scale is obtained. The *lower* end of this tube *is open*, and the mercury supported in it at varying distances by the upward pressure of the atmosphere, very similar in action to that of Howson's Barometer (page 12).

Price, suitably mounted on Mahogany Board, £3 3 0

Like the previously described instrument, this Barometer can only be regarded as a scientific curiosity, and is very subject to become out of adjustment in transit. This is unfortunate, as it and Barometer No. 191 are curiously sensitive, or perhaps we should more properly say, the movements of the mercury are rendered more visible.

FIG 193.

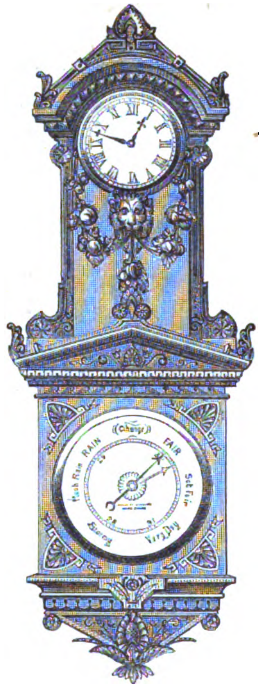


FIG. 194.

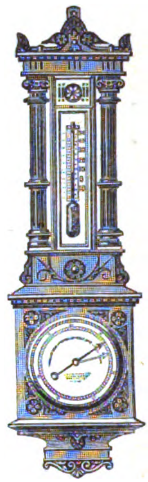


FIG. 193*.

193

ANEROID BAROMETERS.

IN ORNAMENTAL MOUNTINGS.

Since the publication of the early editions of our Illustrated Catalogue we have introduced the Aneroid for use as a household Barometer, mounting it in variously designed ornamental frames, suited either for the Mantel Shelf or for Suspension in the Hall or Library. Our engravings exhibit a few of the series we have had specially designed to suit these instruments.

New patterns are being constantly added to our stock, and we would observe that many of our Dial Barometer frames, such as figs. 163 and 163*, can be mounted with Aneroid Barometers instead of Mercurial Tubes.

One very important advantage of the Aneroid movement thus mounted is that there is *very little fear of damage in transport;* therefore these Barometers can be safely sent abroad to places where hitherto it has been almost impossible to send a mercurial instrument with safety; for beyond careful packing (the Aneroid does not require any screwing up or making portable) nothing is required but to unpack the instrument and hang it up, and it will at once be in action, and show the atmospheric pressure at the place where suspended.

For the saloons of sea-going vessels and yachts, these Aneroid Barometers are admirably adapted, being conveniently small in size, very accurate, not liable to derangement, and highly ornamental. See also page 128.

Price, fig. 193, 193*, £6 6s.; fig. 194, £21; fig. 195, £6 10s.
fig. 198, £18 18s; fig. 196, £5 5s.; fig. 197, £5 5s.

A variety of Aneroids in plainer mountings at proportionately lower prices.

FIG. 195.

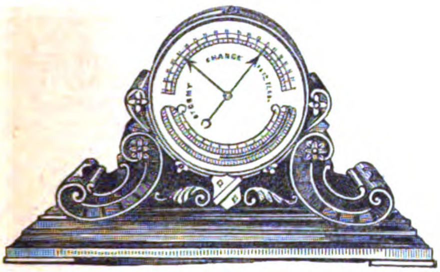


FIG. 196.

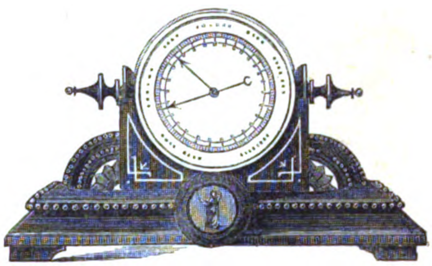


FIG. 197.

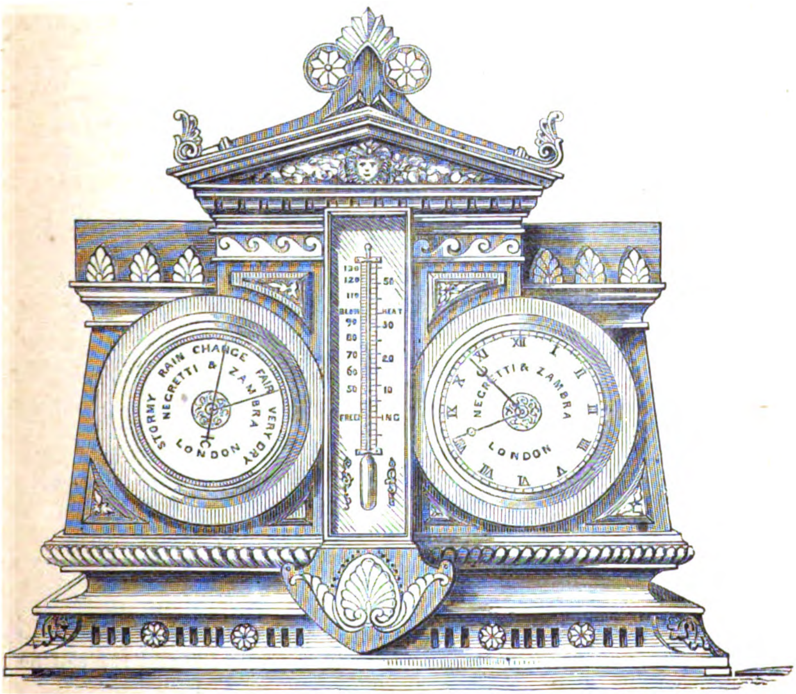


FIG. 198.

NEGRETTI AND ZAMBRA'S DESIGNS
FOR LIBRARY, DINING-ROOM, OR HALL ANEROID BAROMETERS.

FIG. 201.

199 **Ship or Yacht Aneroid Barometers** in strong plain metal or ornamentally carved wood mountings. Extreme convenience of size, combined with great sensibility and reliability, have made these instruments very popular for state cabins of Sea-going Vessels and Steam Ships.

200 **Ships' Aneroids,** plain Circular Bronzed Metal Mountings, with thermometer on the dial . . £3 3 0 £5 5 0 £6 6 0

201 **Ships' Aneroids** in handsomely Carved Wood Frame with thermometer (fig. 201) £6 6 0 8 8 0

202 **Ships' Aneroids,** . . . smaller sizes £3 3 0 3 10 0 4 4 0

203 **Fisherman's or Boat Aneroid,** as suggested to Negretti and Zambra by the late Admiral FitzRoy.

The engraving, fig. 203, represents the exact size of Negretti and Zambra's **Pocket Boat Aneroid,** suited for use of Pilots and Captains of small Coasting or Fishing vessels. The metal case and covering glass is made suitably strong for rough service. Price, in strong case, £3 3 0

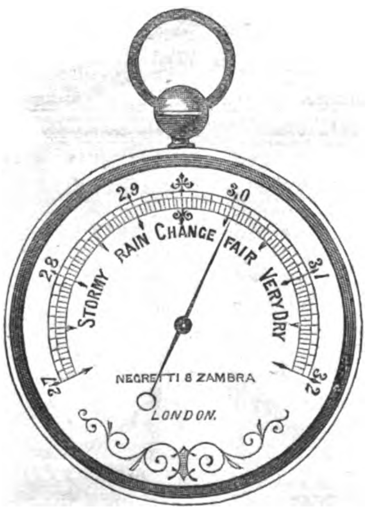


FIG. 203

At pages 14 to 23 will be found a full description of the construction of the various forms of Aneroid Barometers, and at pages 126 and 127 will be found prices for Aneroids in ornamental mountings.

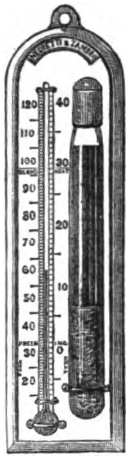


FIG. 205.

FIG. 204.

FIG. 207.

			£	s.	d.	£	s.	d.
204	**Storm Glass or Chemical Weather Glass,** for prognosticating changes in the weather, by sea or land, particularly high winds, storms, or tempests (fig. 204). . . .		0	4	6	0	5	6
205	Ditto	ditto mounted on a boxwood scale, with a Thermometer (fig. 205) . . . 7s. 6d.	0	10	6	0	12	6
206	Ditto	ditto . . . . plain Window Bracket				0	12	6
207	Ditto	ditto best, mounted on Window Bracket (fig. 207).	1	1	0	1	15	0

This curious instrument appears to have been invented more than a hundred years ago. The original maker is not known; but doubtless it is an accidental discovery of some of the old alchemists, who were constantly experimenting with the substances composing the solution with which it is made. It is simply a long glass vial, nearly filled with an alcoholic solution of camphor, to which is added crystals of nitrate of potassa and muriate of ammonia, with a small proportion of distilled water. Air fills the upper part of the vial, the mouth of which is hermetically closed.

The various appearances presented in the liquid and crystals have been noticed to prognosticate atmospheric changes, and rules have been deduced from careful study and comparison of the glass and weather, which are supplied with each instrument. Instructions for using the Chemical Storm Glass sent with each instrument.

Admiral FitzRoy, in *The Weather Book,* writes of this instrument as follows :—

"Since 1825, we have generally had some of these glasses, as curiosities rather than otherwise; for nothing certain could be made of their variations until lately, when it was fairly demonstrated that if fixed undisturbed in free air, not exposed to radiation, fire, or sun, but in the ordinary light of a well-ventilated room, or *preferably*, in the outer air, the chemical mixture in a so-called storm-glass varies in character with the *direction* of the wind—not its force, *specially* (though it *may* so vary in *appearance*, only from another cause, *electrical tension*)."

Some curious information connected with the *Camphor Glass* will be found in two pamphlets written by Charles Tomlinson, Esq., of King's College, London, on The Movements of Camphor on Water, and The Motion of Camphor towards Light. From these papers it would appear that the changes observed in the Storm Glass are due solely to variations of light and heat.

K

THERMOMETERS AND HYDROMETERS.

At pages 27 and 28 will be found described many important improvements in the construction of Thermometers invented and Patented by Negretti and Zambra. Also the process for Engine-dividing the Scales and Tubes, for which a Prize Medal was awarded to Negretti and Zambra at the Great Exhibition of 1851 see (fig. 27°); a second award of Two Medals in 1862, for many important improvements and inventions; a Prize Medal, Santiago, Chili, 1875; and also a Prize Medal for Thermometers, Philadelphia, 1876.

These inventions are applied to all of Negretti and Zambra's instruments enumerated in the following List, where precise accuracy is desirable.

This List will comprise Thermometers of every form and description, suited for Domestic, Medical, Horticultural, Scientific, and Manufacturing purposes, arranged as far as practicable in separate divisions.

Following these, are arranged the various instruments used for ascertaining the specific gravity of fluids, known under the general term of Hydrometers; the whole of the instruments found under this heading with various names showing the same fact, viz., Specific Gravity, by differing scales, from the extremely light and volatile Æthers and Paraffins to the dense and heavy Sulphuric Acid.

In the appendix to this catalogue will be found Rules for comparing the various Thermometer and Hydrometer Scales in general use.

Many years of practical experience in the manufacture of Thermometers and Hydrometers in every variety of shape enables Negretti and Zambra to guarantee the accuracy of these instruments, as regards testing and dividing the scales; at the same time, careful attention is bestowed in their construction, to insure the most improved forms combined with the greatest durability.

The following is an extract from a letter (July, 1877), received by Messrs. Negretti and Zambra, written by Mr. Whipple, the manager of Kew Observatory, with reference to some Thermometers sent down by the firm for comparison.

"I believe I may again assert with confidence, that we have never yet had so large a number of low range Thermometers pass through our hands exhibiting so high a degree of accuracy at the melting point of mercury."

THERMOMETERS.

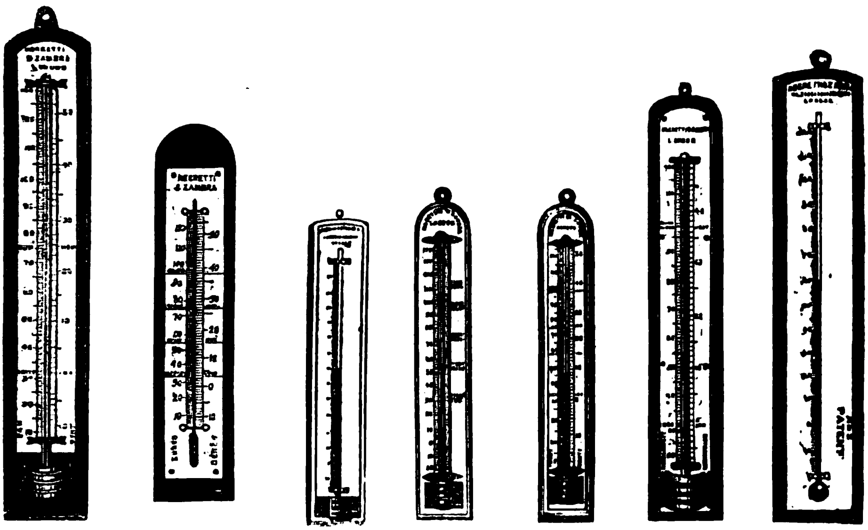


FIG. 216. FIG. 230. FIG. 214*. FIG. 211. FIG. 212. FIG. 218. FIG. 214.

No.	Description	Each. £	s.	d.	Each. £	s.	d.
208	6 or 8-inch **Thermometer, Boxwood Scale** . . .				0	1	0
209	6 or 8-inch ditto, with French polished scale				0	1	6
210	8-inch ditto, superior. A good reliable instrument, suited for Dormitories, Hospital wards, Wine cellars, Stables, &c.				0	2	6
211	6 or 8-inch ditto, **with Enamel tube,** fig. 211				0	3	6
212	6 or 8-inch ditto, **with Enamel tube,** the scale bevelled at the edges, with double scales, either Fahrenheit and Centigrade, or Fahrenheit and Reaumur. Very superior (fig. 212)	0	3	6	0	4	6
213	10 or 12-inch best **Mounted Boxwood Scale Thermometer,** with double or single scales as above 10s. 6d. 12s. 6d.	0	15	0	1	1	0
214	8-inch, 10-inch, and 12-inch Negretti and Zambra's **Patent Porcelain Scale Thermometer** strongly and neatly mounted on oak, Very durable and suited for outdoor exposure (figs. 214 and 214*) . . . . . 7s.	0	12	6	0	15	0

HALL OR DRAWING ROOM THERMOMETERS.

No.	Description	£	s.	d.	£	s.	d.
215	6 or 8-inch **Thermometer,** elegantly engraved **Ivory Scale on Ebony Back,** with German Silver Mountings and double scales . . . . 10s. 6d.	0	12	6	0	16	0
216	10-inch ditto with very bold figures and divisions				1	1	0
217	12-inch ditto, **extra large** (fig. 216)	1	10	0	2	2	0

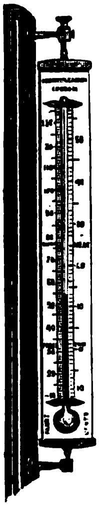


FIG. 245.

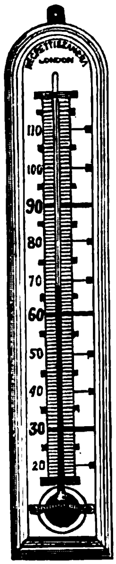


FIG. 219.

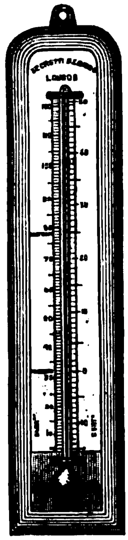


FIG. 218*.

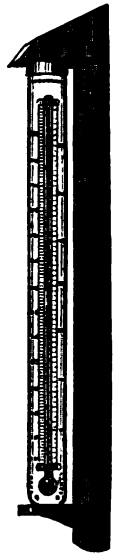


FIG. 242.

No.		* Each. £ s. d.	Each. £ s. d.
218	10 or 12-inch **Thermometers, Engraved Glass Scale,** with German Silver Mountings, superior workmanship, and elegant appearance, on oak, mahogany, or **Ebonised** backs, with Negretti and Zambra's Patent Enamelled tubes, suited for **Halls, Dining Rooms, Libraries, &c.** (figs. 218 and 218*), the divisions and figures very plainly marked. **Spirit or Mercurial** . . . 25s.	1 10 0	2 2 0
219	**Porcelain Mounted Thermometers,** having extra large tubes, either **Spirit or Mercurial,** with very legible scales and words (fig. 219) . . . 12s. 6d. 15s.	1 1 0	1 15 0

PORTABLE OR POCKET THERMOMETERS.

No.		£ s. d.	£ s. d.
220	3 or 4-inch **Ivory or Metal Scale Pocket Thermometer,** in morocco leather hinged case (fig. 220)	0 4 6	0 5 6
221	6-inch ditto . . . . . . ditto (fig. 221)	0 6 6	0 8 6
222	8-inch ditto . . . . . . ditto (fig. 221)	0 10 6	0 12 6
223	**Oval Boxwood Pocket or Dressing Case Thermometer,** with tube and bulb sunk in the solid wood, to prevent breakage in travelling . . . . . (fig. 223)		0 7 6
224	Ditto. ditto . . . . larger		0 10 6
225	**Oval Ivory** ditto ditto		0 15 0
226	Ditto, ditto . . larger size (fig. 226)		1 1 0
227	**Negretti and Zambra's Improved Travelling Thermometer,** in plated metal or silver case (fig. 227) .	0 10 6	1 1 0

Not larger than a pencil case; accurately divided on its own stem. Can be arranged as a small Clinical Thermometer.

No.		£ s. d.	£ s. d.
228	**Negretti and Zambra's Pocket Travelling Thermometer,** German silver Revolving Case, and ivory scale (fig. 228)	0 11 0	0 15 0
229	Ditto, ditto, ... extra large (fig. 229)		0 18 6
230	**Pocket Thermometer in Slide Lid Wood Cases,** with Ivory or Metal scale (fig. 230) . . . 6s. 6d.	0 10 6	0 15 0

FIG. 227.

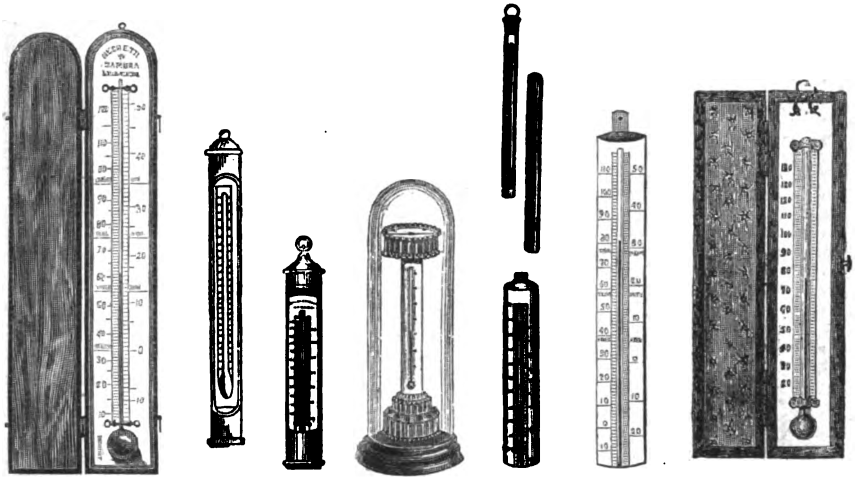


FIG. 221. FIG. 229. FIG. 228. FIG. 238. FIG. 223. FIG. 226. FIG. 220.

No.	Description	Each. £ s. d.	Each. £ s. d.
230*	**Pocket Thermometers** in elegant hinged cases of Tortoise-shell and Shagreen . . . . . 15s.	1 5 0	1 15 0
231	**Circular Pocket Thermometer** with **Ivory** scale, in leather case, 2 inches in diameter		0 18 6
232	Ditto, 3 inches in diameter, with **Compass** in centre .		1 5 0
233	Ditto, 3 inches in diameter, with **Compass and Sun Dial** in centre	1 10 0	1 16 0

MANTEL OR TABLE THERMOMETERS.

No.	Description	Each. £ s. d.	Each. £ s. d.
234	**Boxwood Scale Thermometer, on Ebony Stand** (fig. 234)		0 10 6
235	**Ivory Scale Thermometer on Ebony Stand,** with glass shade . . . . 10s. 6d.	0 12 6	1 10 0
236	**Ditto, on Solid Ivory stand** . . . . . (fig. 236)	1 10 0	2 2 0
237	**Ivory Mantel Thermometers,** handsomely engine-turned, and ornamented in numerous designs (figs. 237 & 237*) £2 2 0	3 3 0	5 5 0
238	**Ditto, with Compass or Sun Dial** at top (fig. 238) .	1 15 0	2 2 0
238*	**Ivory Scale Mantel Thermometers,** mounted on Ebony with **solid marble base** (as fig. 236) 15s., 21s. . . .	1 10 0	1 15 0
239	**Ornamental Marble Mantel Thermometer,** as fig. 239 **Obelisk** and various other patterns from	1 10 0	2 2 0

WINDOW THERMOMETERS FOR OUT-DOOR USE.

No.	Description	Each. £ s. d.	Each. £ s. d.
240	**Window Thermometer**, plain wood or PORCELAIN SCALE, on a **Wood Bracket**		0 12 6
241	**Window Thermometer,** 8-inch Ivory or Glass Scale, enclosed in glass cylinder, on oak **Bracket,** with metal top		0 15 0
242	10-inch . . . . ditto ditto (fig. 242)		0 18 0
243	12-inch . . . . ditto . . .	1 5 0	1 10 0

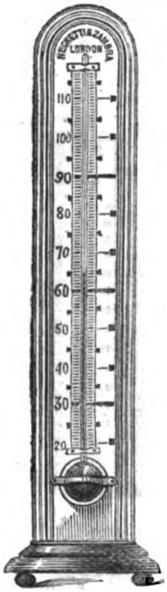


FIG. 234.

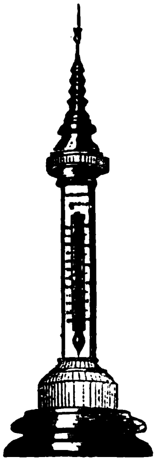


FIG. 237.


FIG. 239.

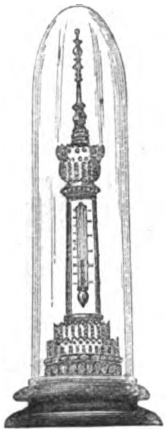


FIG. 237*.

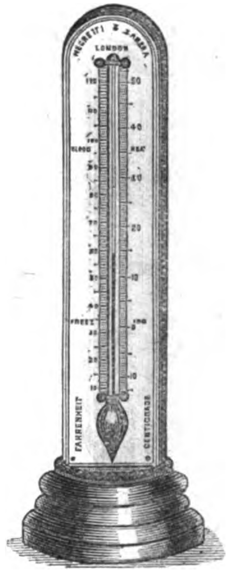
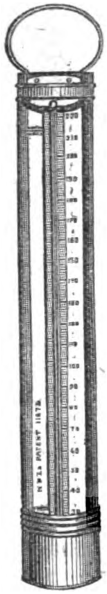


FIG. 236.

No.	Description	Each. £ s. d.	Each. £ s. d.
244	**Window Thermometer,** 10, 12, or 14-inch Patent Porcelain Scale, mounted on oak or mahogany **Bracket,** for fixing at any angle	1 1 0	1 15 0
245	**Window Thermometer,** engraved Glass Scale, with enamel tube, the scale divided by engine, and handsomely mounted on oak **Bracket,** with brass supports for fixing at any angle (fig. 245) . . . . . 35s.	2 2 0	3 3 0

HORTICULTURAL AND BOTANICAL THERMOMETERS.

No.	Description	Each. £ s. d.	Each. £ s. d.
246	8-inch **Botanical Thermometer, Boxwood Scale,** in japanned metal cases, range of scale 0 to 120° or 150°		0 3 6
247	Ditto ditto ditto 10-inch		0 5 6
248	Ditto ditto 12 to 14-inch **Boxwood Thermometers,** do. do.	0 7 6	0 10 6
249	8-inch **Thermometers on Negretti and Zambra's Patent Porcelain Scales,** not affected by damp, &c., in japanned metal cases		0 5 6
250	10-inch ditto ditto . . .		0 7 6
251	12-inch ditto ditto		0 10 6
252	14-inch ditto ditto		0 12 6
253	**Hot bed Thermometer,** in plain metal mounting (fig. 253)		0 12 6
254	Ditto ditto, in mahogany frame, encased in brass cylinder	1 5 0	1 10 0
255	Ditto ditto, with Thermometer on the door (fig. 255) .		1 10 0
256	**Ground Thermometer,** for ascertaining the temperature of the earth (figs. 256 and 281). See also page 30	0 10 0	0 15 0
257	**Delicate Thermometers,** for inserting in the stems and flowers of growing plants, divided on the stem . .		0 10 6
258	Ditto ditto Registering and extremely sensitive		1 1 0



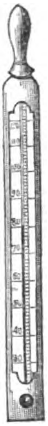


FIG. 284.

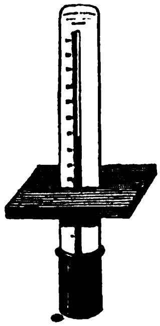


FIG. 282.

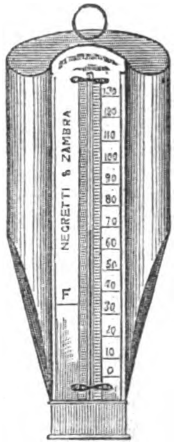


FIG. 283.

FIG. 268*.

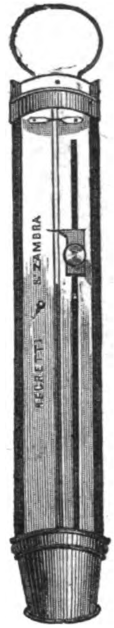


FIG. 270. FIG. 262. FIG. 268.

BREWERS' THERMOMETERS.

No.		Each. £	s.	d.	Each. £	s.	d.
259	8-inch **Brewers' Thermometer** Silvered Metal scales, in japanned metal case	0	3	0	0	5	0
260	10-inch ditto ditto . . .	0	3	6	0	6	0
261	12-inch ditto . . .	0	4	6	0	5	6
262	14-inch ditto ditto (fig. 262) . . .	0	7	6	0	10	6
263	8-inch Enamelled Tubes, in **Copper Cases** . . .				0	6	6
264	10-inch ditto ditto				0	7	6
265	12-inch ditto ditto				0	10	6
266	14-inch ditto ditto				0	12	6
267	**Best Mounted Brewers' Thermometer,** extra stout scales and Scoop shape rivetted case (as fig. 268) . . .	0	12	6	0	16	0
268	**Brewers' Thermometers,** Best Mounted with **Blind Scales,** in stout Copper cases (figs. 268 and 268*) .				0	18	0
269	Ditto ditto **lettered** instead of figured				0	18	6
270	**Brewers' Standard Reference Thermometers** (fig. 270) .	1	1	0	2	2	0
271	8-inch **Brewers' Thermometer,** PORCELAIN SCALES, Negretti and Zambra's **Patent** range of scale, 212°, in japanned metal cases (as fig. 262)				0	5	6
272	10-inch ditto ditto . . .				0	7	6
273	12-inch ditto ditto . . .				0	10	6
274	14-inch ditto ditto . . .				0	12	6
275	8-inch ditto **Brewers' Thermometers,** Patent Porcelain Scales, in **Copper** cases (fig. 262)				0	7	6
276	10-inch ditto ditto . . .				0	8	6
277	12-inch ditto ditto . . .				0	12	6
278	14-inch ditto ditto . . .				0	14	0

Stout Rivetted Copper Cases at a slight advance on above.

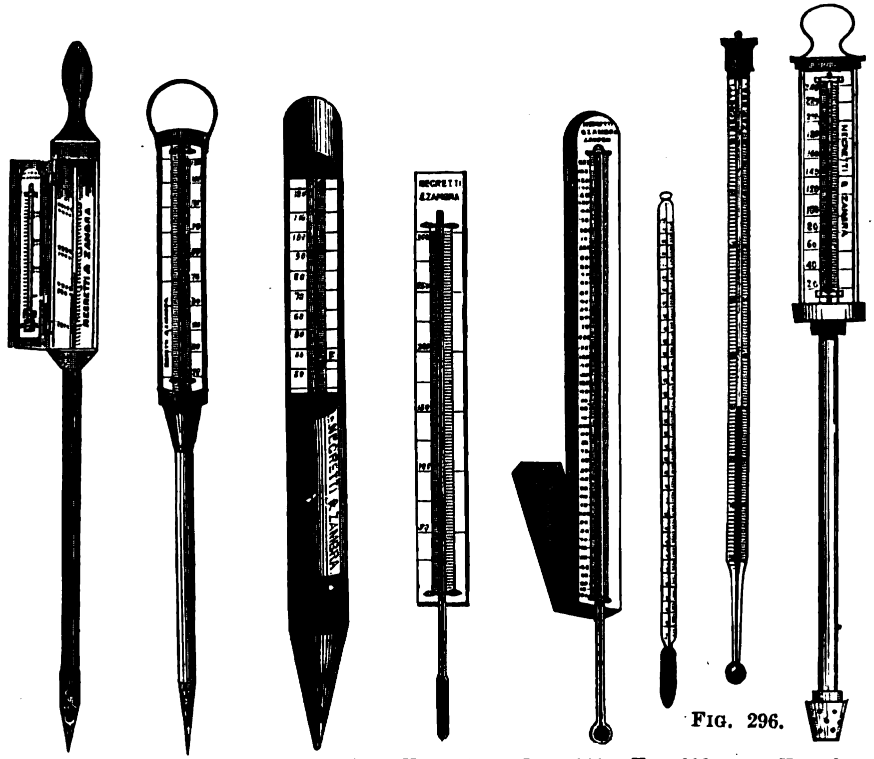


FIG. 296.

FIG. 255. FIG. 253. FIG. 281‡. FIG. 287. FIG. 289. FIG. 291. FIG. 281.

No.		Each. £ s. d.	Each. £ s. d.
279	**Gyle Tun Thermometers,** according to length, strong wood mountings with N. and Z.'s Patent Porcelain Scales and enamelled tubes. 3ft., 36s.; 4ft., 42s.;	5ft., 50s.;	6ft. 60s.;
280	**Vatting Thermometers,** Metal Scale and Wood mountings 3 feet stem		1 10 0
280°	Ditto, ditto 4 feet do.		1 16 0
281	**Mash Tun Thermometers,** Patent Porcelain Scales in strong **Metal** mountings (fig. 281).	3ft., 45s.;	5ft., 50s.
281*	**Saccharometer Thermometer** with expansion scale, enamelled tube on stout metal mounting		0 12 6
281†	**Brewery Yard Thermometers** registering heat and cold. See Nos. 320 to 326	0 15 0 to	2 10 0
281‡	**Malt Kiln Thermometer,** stout oak mount and brass fittings (fig. 281‡)	0 10 6	0 12 6

BATH THERMOMETERS.

BATH THERMOMETERS, WITH SILVERED METAL, OR NEGRETTI AND ZAMBRA'S PATENT PORCELAIN SCALES, IN JAPANNED METAL, OR COPPER CASES, SAME PRICE AND FORM AS BREWERS' THERMOMETERS. PAGE 135.

No.		Each. £ s. d.
282	**Floating Bath Thermometers,** for keeping constantly in water (fig. 282)	0 7 6
283	Improved form of ditto ditto, with Porcelain Scale (fig. 283)	0 15 0
284	**Bath Thermometer** (fig. 284) Porcelain Scale in strong wood mounting	0 12 6
284°	**Dairy Thermometers,** with Ivory and Boxwood Mountings	0 10 6

No.	Description	Each. £ s. d.	Each. £ s. d.
285	**Dairy Thermometer** N. and Z.'s Patent Porcelain Scales with Silver Mountings	0 12 6	0 15 0
286	Ditto ditto in Isolated Glass Tube 3s. 6d.	0 5 6	0 7 6

The Isolated Thermometers are made entirely of glass, and moderate in price; they are easily cleaned, and eminently adapted for common dairy, nursery, or culinary purposes.

CHEMICAL AND SURGICAL THERMOMETERS.

No.	Description	Each. £ s. d.	Each. £ s. d.
287	**Chemical Thermometers with plain Boxwood Scale,** graduated to 300°, the bulb projecting below the scale (fig. 287)		0 5 6
288	Ditto, with brass hinge jointed boxwood scale, to 300°		0 8 6
289	Ditto, superior enamel tube, and French polished, 600° (fig. 289)		0 12 6
290	**Chemical Thermometer,** graduated on stem for inserting in the tubulure of retorts, to 400°		0 5 6
291	Ditto ditto, to 600° (fig. 291)		0 7 6
292	Ditto, best make, **Enamelled tube,** and engine divided		0 10 6
293	Ditto ditto, very finely divided to half degrees and tenths	0 15 0	1 1 0
294	**Standard Thermometers** (fig. 270) see page 135 also 28.		2 2 0
295	**Thermometers Isolated in Glass Cylinders, for Acids or corrosive liquids** 40° to 300°		0 5 6
296	Ditto, ditto 40° to 600° (fig. 296)		0 7 6
297	**Delicate Thermometers of extreme delicacy, various** forms for physical investigation	0 10 6	0 15 0
298	Ditto, Negretti and Zambra's patent **Self-registering** ditto	0 10 6	0 15 0

NEGRETTI AND ZAMBRA'S CLINICAL THERMOMETERS†.

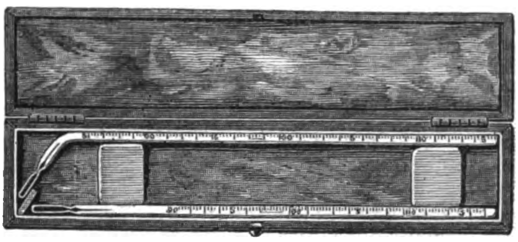


FIG. 299†.

299 **Clinical Thermometers** (Aitkin's), Negretti and Zambra's improved. These instruments were first applied to medical purposes by Dr. Aitkin of the Royal Hospital, Netley, and their use fully described in Aitkin's *Science and Practice of Medicine.*

Clinical Thermometers are made of two forms, viz., straight and curved.

1.—**A Straight Thermometer,** divided on the stem (fig. 299), which, being a maximum self-registering one, does not require to be read *in situ*, but may be removed from contact with the part, and read when convenient. Both Thermometers are graduated to at least 110° or 115° Fahr., and each degree divided into *fifths.*

2.—**A very sensitive Thermometer,** also divided on the stem (fig. 299*), made **with a curve,** in order that its bulb may be the more easily and perfectly fitted into the axilla, while the stem, being carried upwards, renders the reading *in situ* more easy.

† See also Section Surgical Instruments at the end of Catalogue.

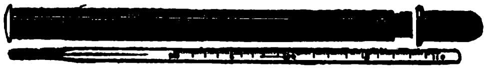


FIG. 299.

DIRECTIONS FOR USE.

I.—THE STRAIGHT CLINICAL THERMOMETER.—1. Its index must be set *before* commencing to take an observation.

[N.B.—The index is the bit of mercury detached from THE COLUMN IN THE STEM OF THE INSTRUMENT.]

2. This index is to be set by bringing the bit of detached mercury down into the clear part of the stem, just below the lines which indicate the degrees. This is done by taking the bulb and stem of the instrument firmly in the hand, and then, by *a single rapid swing of the arm*, the index will come down the stem; and this *swing of the arm* must be repeated till the top of the index is at least below the lines indicating the degrees.

3. After the index has thus been set, the bulb of the instrument may then be applied to the axilla, or any part which is completely covered; and, being retained in close apposition (by strapping if necessary) with the surrounding soft parts for any length of time, the instrument is to be carefully and gently removed.

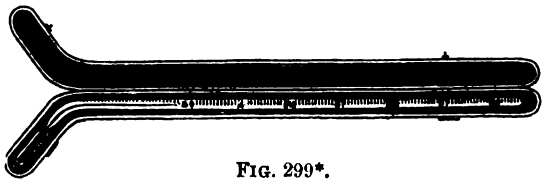


FIG. 299*.

II. THE CURVED CLINICAL THERMOMETER,—Its bulb must be well fitted into the arm-pit, being introduced below the fold of the skin covering the edge of the *pectoralis major* muscle, and so kept in close contact with the skin, completely covered and firmly surrounded by the soft parts. In very thin or very old persons this adjustment requires special care. The instrument must be retained *in situ* during a period of not less than *three minutes;* and the height of the mercury in the graduated stem must be read *while the Thermometer is still undisturbed in the axilla*, care being taken that the axis of vision falls perpendicularly on the column of mercury in the tube, when the *top of the index—i.e.*, the end farthest from the bulb—will denote the *maximum temperature* during the period the instrument has been in perfect contact with the parts.

The normal temperature of the human body, at completely sheltered parts of its surface, amounts to 98·5° Fahr., or a *few tenths* more or less; and a rising above 99·5° Fahr., or a depression below 97·3° Fahr., are sure signs of some kind of disease, *if such increase or depression is persistent.*

The average temperature of the trunk of the body in the Tropics is nearly *one degree* higher than in temperate regions.

The increase of temperature above 99° Fahr., *as measured by the Thermometer*, is *the best index* of the amount of fever present in any disease.

The temperature of the body in disease is much more readily and rapidly influenced than either the pulse or the respiration.

Printed instructions for use given with the Clinical Thermometers, and further particulars of their practical application may be found in Dr. Aitkin's book previously referred to.

		£	s.	d.
300	**Clinical Thermometer,** No. 1. Straight, self-resisterirg, in Pocket case, (fig. 299)	0	10	6
301	Ditto ditto, No. 2. Curved, in ditto ditto (fig. 299°)	0	10	6
302	**Clinical Thermometers,** Nos. 1 and 2, in hinged morocco leather case (fig. 299†)	1	1	0
303	Ditto ditto, of larger size for Hospital use, in mahogany case	1	5	0

Clinical Thermometers with Centigrade Scales at the same prices as above list.

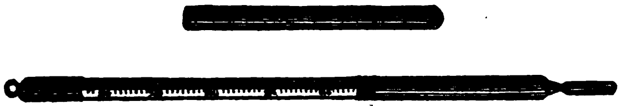


FIG. 305.

No.	Description	Each. £ s. d.	Each. £ s. d.
304	**Veterinary or Cattle Plague Thermometers,** of similar construction to Clinical Thermometers, but larger and more strongly mounted, in stout pocket case . .		0 12 6
305	Ditto ditto, in ditto, with protecting sheath (fig. 305)		0 14 0
306	**Dentist Thermometers,** for **Vulcanising** process . .	0 10 6	1 5 0
307	Ditto ditto made to order and drawings		

Disinfecting Thermometers; see Special Thermometer Section.

SELF-REGISTERING THERMOMETERS FOR HEAT.

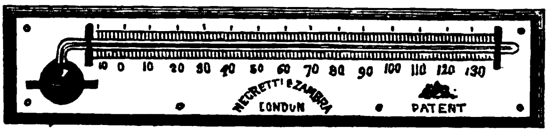


FIG. 313.

No.	Description	Each. £ s. d.	Each. £ s. d.
308	**Rutherford's Maximum Thermometer,** on boxwood or metal scale, with steel or Graphite index	0 5 6	0 7 6
309	Ditto, on Negretti and Zambra's Patent Porcelain Scale		0 10 6
310	**Phillip's Maximum Thermometer,** on boxwood or metal scale, with **Air Index**		0 10 6
311	Ditto ditto, on Negretti and Zambra's Patent Porcelain or metal Scale		0 10 6
312	**Negretti and Zambra's Patent Maximum Thermometer,*** on boxwood scale		0 10 6
313	Ditto, ditto, on Negretti and Zambra's Patent Solid Porcelain or Metal Scales and Oak mounting, (fig. 313)		0 12 6

SELF-REGISTERING THERMOMETERS FOR COLD.

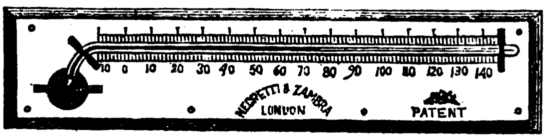


FIG. 317.

No.	Description	Each. £ s. d.	Each. £ s. d.
314	**Rutherford's Minimum Thermometer,** on boxwood or metal scale . . . . 3s. 6d.	0 5 6	0 7 6
315	Ditto, ditto, superior mountings		0 10 6
316	Ditto, on Negretti and Zambra's Patent Solid Porcelain Scale		0 12 6
317	Ditto ditto on Patent Porcelain or Metal Scales and Oak mounting (fig. 317)		0 12 6

* This Instrument is the only Maximum Thermometer that can be recommended, as unless it be broken it cannot be put out of adjustment; all others are liable to become defective in transit. It is fully described under the head of Standard Maxima Thermometers, pages 31 and 32, and at page 37 will be found particulars of the construction and use of Minima Thermometers.

FIG. 318.

318 NEGRETTI AND ZAMBRA'S CELEBRATED

HORTICULTURAL SELF-REGISTERING THERMOMETER.

For determining the greatest cold during the night or absence of the observer. This instrument is a Spirit Minimum Thermometer, similar in construction to No. 46, page 37. The lowest temperature being recorded by a black glass index floating in the spirit. The scale is made of stout zinc, enclosing the tube; the figures and divisions being boldly marked for *quickly* and *easily* reading the indications.

(fig. 318) *Price*, 3s. 6d.

Strongly recommended in all the leading Horticultural Journals as the cheapest and best registering thermometer of the kind for garden purposes.

Many hundreds of grosses of these registering thermometers have been sold, giving universal satisfaction. Instructions for use given with each instrument.

SELF-REGISTERING THERMOMETERS FOR HEAT AND COLD.

One of the most elegant and ingenious Registering Thermometers is that invented many years back by James Sixe, Esq., of Colchester.* It records the highest and lowest temperature (or heat and cold, as it is commonly termed) during any given period of time in an exceedingly simple and convenient manner, and also at any moment showing present temperature.

319 NEGRETTI & ZAMBRA'S IMPROVED SIXE'S SELF-REGISTERING THERMOMETER FOR HEAT AND COLD.

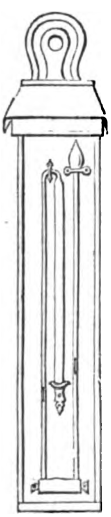


FIG. 319.

Consists of a long cylindrical bulb united to a smaller tube of more than twice its length, bent round each side of it in the form of a syphon, and terminating in a small pear-shaped bulb, as shown in the engraving (fig. 319). The lower portion of the bent tube is filled with mercury; and the long bulb, the upper parts of the tube, and part of the small bulb, with highly-rectified alcohol. In the tubes will be found two steel needles or indices, terminated at top and bottom with a bead of glass, to enable them to move with the least possible friction. These needles would from their weight, rest upon the mercury; but each has a fine hair tied to its upper extremity and bent against the interior of the tube, acting as a spring with sufficient elasticity to keep the index supported in the spirit at any point to which they may be raised in the tube by the mercury.

The instrument acts as follows:—A rise of temperature causes the spirit in the long bulb to expand, and pressing the mercury down the left hand tube causes it to rise in the opposite one, raising the index with it until the highest temperature is attained. The lower end of the index then indicates upon the engraved scale the maximum temperature As the temperature falls, the spirit and the mercury contract, and in returning towards the long bulb the opposite index is carried up by the mercury until the lowest temperature occurs, where it is left indicating upon the scale the minimum temperature.

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* See "Philosophical Transactions" for the years 1782 and 1790. By some writers the name is spelt x, and of Canterbury.

The scale on the right hand is an ascending one, and on the left descending, as will be seen in our engraving (fig. 319). The thermometer is set for observation by drawing the indices down to surface of the mercury by a small magnet, which attracts the steel through the glass, so that it is easily moved up or down. They should be drawn nearly to the top of the tubes when it is desired to remove the instrument, which should be *carefully carried in the vertical position;* for should it be inverted, or laid flat, it may become put out of order. For transmission by ordinary conveyances, it requires that attention be given to *keep it vertical.* Sixe's Registering Thermometers should be always hung *strictly in the shade.*

These Thermometers, when carefully made and adjusted to a standard thermometer, are recommended as very convenient for ordinary purposes, where strict scientific accuracy is not required.

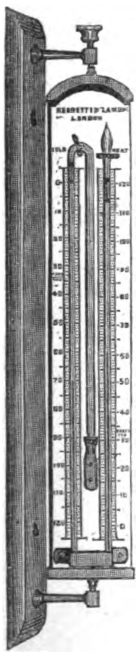


FIG. 330.

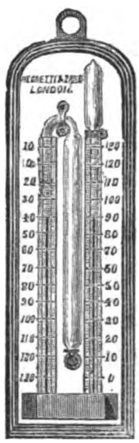


FIG. 325.

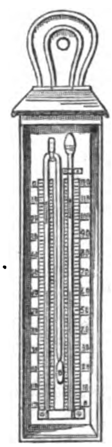


FIG. 320.

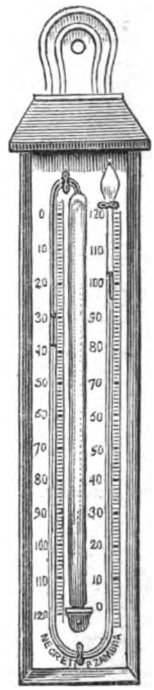


FIG. 322

		Each. £	s.	d.	Each. £	s.	d.
320	**Sixe's Registering Thermometer,** 10-inch, on boxwood or metal scale, in japanned metal case (fig. 320) . .	0	14	0	0	15	0
321	Ditto 12-inch ditto ditto				1	1	0
322	Ditto 14-inch ditto (fig. 322)				1	15	0
323	Ditto 10-inch, on **Ivory** Scale in japanned case Copper cases, 3s. extra.				2	2	0
324	**Sixe's Registering Thermometer,** with Negretti and Zambra's Patent **Porcelain Scale,** in japanned metal case (fig. 320) . . . . 21s.	1	10	0	2	2	0
325	Ditto ditto, **Porcelain Scale,** on Oak or Ebonised Wood, back, suited for Halls, Libraries, Dining Rooms, Passages, etc. (fig. 325)	1	16	0	2	2	0
326	**Sixe's Registering Thermometer,** with Opal Glass Scale and the divisions and figures enamelled and burnt in, mounted on Oak or ebonised Wood (fig. 325) . .	2	2	0	2	10	0

No.		Each. £ s. d.	Each. £ s. d.
328	**Sixe's Registering Thermometer,** with Bronzed Metal Mountings on mahogany board for suspending outside a window, Patent Porcelain Scales		1 16 0
329	Ditto ditto ditto with enamel tube and Engraved Glass scale (fig. 330)	2 2 0	2 10 0
330	Ditto ditto ditto **extra large size Patent Porcelain or Glass Scale,** and very legible figures and divisions (fig. 330)		3 3 0

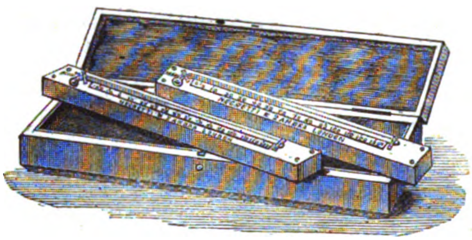


FIG. 331.

No.		Each. £ s. d.	Each. £ s. d.
331	**Negretti and Zambra's small size Patent Maximum and Minimum Thermometer,** arranged in a mahogany case, suited for travellers to whom size and weight is an object (fig. 331)		2 2 0
332	Ditto ditto, larger **Standard** size, see also page 42		2 10 0

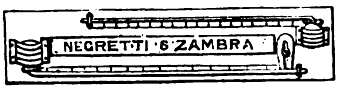


FIG. 333.

No.		Each. £ s. d.	Each. £ s. d.
333	**Rutherford's Day and Night Registering Thermometer,** on a boxwood scale, with a magnet (fig. 333) . . .	0 15 0	1 10 0

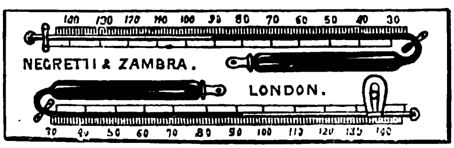


FIG. 334.

No.		Each. £ s. d.	Each. £ s. d.
334	**Day and Night Registering Thermometer,** with *Cylinder Bulbs* and enamel tubes of large internal diameter. The Maximum Thermometer, either Negretti and Zambra's Patent or Phillips's arrangement, and each tube mounted on a separate scale, but joined together with a screw in order that the Thermometers can be used either combined or alone (fig. 334)		2 2 0
334*	**Negretti and Zambra's large sized Maximum and Minimum Sea Coast Registering Thermometers,** with Porcelain Scales, as constructed for Admiral FitzRoy		2 2 0

FOR STANDARD SELF-REGISTERING THERMOMETERS, see pages 31 *to* 45.

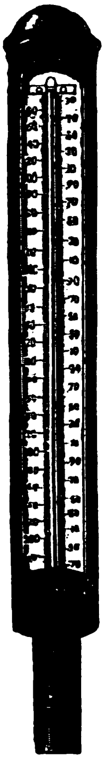
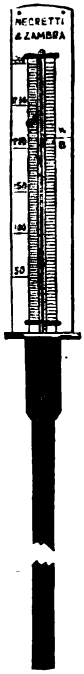



FIG. 362. FIG. 364.

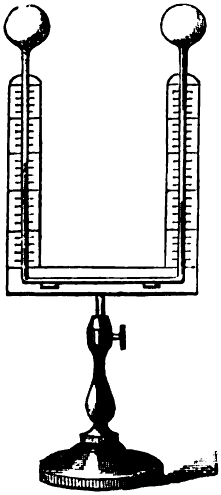


FIG. 351.

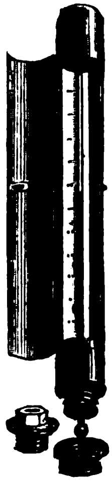



FIG. 354. FIG. 355

FIG. 256.

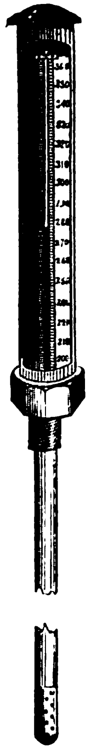


FIG. 341.

THERMOMETERS FOR SPECIAL PURPOSES.

No.		Each. £	s.	d.	Each. £	s.	d.
335	**Oven Thermometers** for high temperatures, on stand .	0	14	0	1	6	0
336	Ditto, Negretti and Zambra's Patent self-registering .	1	1	0	1	10	0
336°	**Pit Thermometers, (Mining)**	0	2	6	0	12	0
337	**Dairy Thermometers,** with ivory mountings, various. See No. 284 to 286.						
338	**Beehive Thermometers.** See No. 223, . Boxwood .	0	7	6	0	10	6
339	**Soap Boilers' Thermometers**				0	10	6
340	**Dentists' Thermometers,** for vulcanising process. See Nos. 306 and 307. . . . . 12s. 6d.	0	15	0	1	5	0
341	**Sugar-boiling Thermometer,** 3 to 4 feet long, graduated to 300°, strongly mounted . . . . . (fig. 341)	1	12	0	2	2	0
342	**Sugar-boiling Thermometer,** 14-inch stout metal scales, divided to 300° in stout rivetted copper cases . .				0	16	0
343	**Confectioners' Thermometers,** isolated glass tubes, to 300°	0	5	0	0	7	6
344	Ditto ditto ditto divided on the stem to 300° or 600°.				0	10	6

345 **Chemical Manufacturers' Thermometers,** suited for acid or corrosive liquids, or general laboratory use. See Nos. 287 to 293, also pages 28 and 137.

		Each. £ s. d.	Each. £ s. d.
346	**Vinegar Makers' Thermometers,** various.	0 2 0	0 5 6
347	Ditto ditto without any metal mountings, as fig. 284.	0 10 6	0 15 0
348	**Varnish Makers' Thermometers,** with strong metal mountings, 3 feet long, form as fig. 341	1 16 0	2 2 0
348*	**Hay Stack Thermometers,** similar in form to fig. 341 .		1 10 0
349	**Boiling Point Thermometers,** for determining heights by observing the boiling point of water, see page 71 .		1 10 0
350	**Alarm or Valve-regulating Thermometers,** mounted on a mahogany board or brass stand . . . from		2 2 0
350*	**Thermostat** for similar purposes as above, an arrangement of metallic bars of different metals		made to order.
351	**Leslie's Differential Thermcmeters,** for delicate experiments on radiant heat, &c., (fig. 351)	1 10 0	2 2 0
352	**Air Thermometers,** for ditto ditto	0 15 0	1 1 0
	Boyle's arrangement, one of tho carliest forms of Thermometer used.		
353	**Still Thermometers** of various lengths and mountings		fig. 341 made to order.
354	**Steam Pressure Thermometers** (or Thermo-Pressure Guage), in strong brass case (fig. 334)	1 5 0	1 15 0
355	Ditto ditto with hinged door and plug for closing the boiler when the Thermometer is not in use (fig. 355) .		2 2 0
356	**Hot Water Thermometers,** for low pressures, small size (similar shape to fig. 334) for attaching to Hot Water Warming apparatus, &c.	0 18 0	1 4 6
356°	**Cooking or Culinary Thermometers,** (Fryometer) of various forms, see also 335 and 336		
357	**Vacuum Pan Thermometers,** stout brass mounting with hinged or revolving door, as fig. 355		2 2 0
358	**Hot Air Thermometers,** for Turkish Baths, various forms . . . . 18s.	1 5 0	1 16 0
358°	**Upcast Shaft Thermometers,** Self-Registering from 50° to 550° enclosed in round Copper Case		1 12 0
359	Ditto ditto or **Hot Blast Thermometer,** for high temperatures in furnace shafts (fig. 362) . . .		1 10 0
359*	**Registering Air Shaft Thermometers,** Negretti and Zambra's Improved, for ditto ditto See next page .		2 2 0
360	**Super Heated Steam Thermometers, with Patent Porcelain Scales,** in strong japanned Iron Mountings (fig. 362)		1 10 0
361	Ditto ditto ditto smaller size.		1 5 0
362	**Super Heated Steam Thermometers,** with **Brass** mountings, as figs. 354 or 355	2 2 0	2 10 0
363	**Salinometer Thermometer.** See Salinometer . .		0 6 6
363*	**Stout Copper Trial Pots** for ditto with division . .		0 8 6
364	**Disinfecting Thermometers,** for Hospital, Workhouse, or Mortuary use, simple form, (fig. 364) . . 16s.	1 5 0	1 16 0
365	Ditto ditto, **Bent Form,** of any length of Tube or Scale		*to order* and drawings
366	**Reference** *Standard* **Thermometers.** See page 135, fig. 270 and page 28		2 2 0
366°	**Hydrometer Thermometer,** with Ivory Scale . .		0 7 6
366†	**Saccharometer Thermometer,** with expansion Scale on Silvered Metal		0 14 0

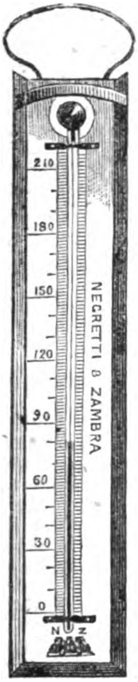


FIG. 368.

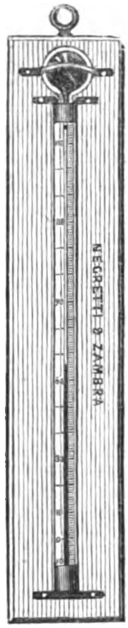


FIG. 369.

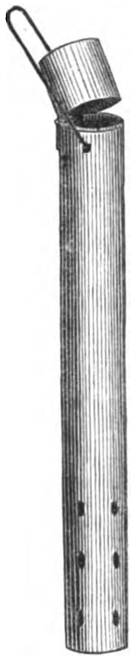


FIG. 370*.

FIG. 370.

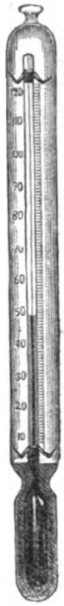


FIG. 371.

NEGRETTI AND ZAMBRA'S

PATENT SELF-REGISTERING MAXIMUM THERMOMETER

For ascertaining Underground Temperature, the Temperature of Mines, Thermal or Boiling Springs, Air Shafts, Atmospheric Temperature, &c., &c.

367 The above engravings represent various forms of **Negretti and Zambra's Patent Self-Registering Thermometers**, each adapted to a special purpose; these can be made available in many other ways not here specified. The principles on which these instruments are constructed, and the manner of using them is fully set forth on pages 36 and 37.

Particular instructions are supplied with each Thermometer.

368 Fig. 368 represents a **Brewer's Self-Registering Thermometer**, by which accurate temperatures may be ascertained in positions inconvenient of access or where **Steam, Heat**, or **Darkness** render the true readings of an ordinary Brewer's Thermometer almost impossible to be obtained.

Price in Stout Copper Case, £1 1 0

369 Fig. 369 shows another form of the Thermometer divided on its stem, arranged in a Glass Sheath mounted on a Mahogany Board or Metal Plate, for ascertaining temperatures in Hot Air or Drying Chambers, Baths, Ovens, &c., &c., serving as a check on temperatures during absence; or, as described pages 36, 37, and 45, as a Marine Atmospheric Maximum Thermometer. *Price*, £1 1 0

370 Fig. 370 and fig. 371† are other arrangements of this Thermometer, made by Negretti and Zambra under special instructions from Professor Everett, for the Committee of the British Association on Underground Temperatures.

Fig. 370 is the Thermometer, enclosed in a Glass Tube or Sheath, fitting into a hinged Copper Protecting Case (Well Thermometer), as seen in fig. 370*.

Price, £1 5 0

371 Fig. 371 is a **Thermometer of very Slow Action** for taking direct **Earth Temperatures.** The bulb of this Thermometer is shown in its Glass Sheath surrounded by a good non-conducting substance as suggested by Professor Everett. The Thermometer being lowered down to the desired depth by a cord, is allowed to remain a considerable time in the earth so as to attain the existing Temperature. It is then withdrawn quickly, and the reading noted, the non-conductor around the Bulb preventing any rapid change taking place for a sufficient time to insure accuracy. *Price,* £0 18 6

The following extract from the Fourth Report of the Committee on Underground Temperature, British Association for Advancement of Science, 1871, will sufficiently prove the advantages of Negretti and Zambra's Patent Thermometer without further comment :—

"The Thermometer which the Committee have been employing for the last three years is a Phillips's Maximum, having so fine a bore that the detached column of mercury which serves as the index is sustained in the vertical position by capillary action, and will bear a moderate amount of shaking without slipping down. Numerous instances, however, have occurred in which the index has slipped in consequence of jerks or concussions sustained by the thermometer in hauling it up from a depth. During the past six months the Secretary † has been in correspondence with Messrs. Negretti and Zambra respecting a proposed modification of the Maximum Thermometer known by their name, which occurred to him more than a year ago, and was described by him privately to some meteorological friends at the last Meeting of the Association. It was then supposed to be new, but it now appears that Messrs. Negretti and Zambra have made something of the kind for the last fourteen or fifteen years. Several changes, however, were necessary before the thermometer was adapted to the uses of the Committee, and the first complete instruments were received in June last. They are enclosed, like the thermometers previously used, in hermetically sealed tubes, for protection against pressure, and they have the advantages (1) *of being able to bear more severe jolts without derangement of their indications, and* (2) *of presenting to view a much broader column of mercury, so as to be more easily read in a dim light.*"

At the meeting of the British Association in 1872 (Brighton), Prof. Phillips when speaking on the subject of the use of his own form of Thermometer for ascertaining underground temperatures, said, "There would be difficulty in using such instruments where the light was bad, and he thought the instrument exhibited by Prof. Everett (Negretti's Vertical Thermometer) was better adapted to the purposes of the Committee."

The Range of Scale of these Maximum Thermometers can be varied to suit the requirements of the experiments to be carried out.

Artesian Well, Hanwell, 290 ft. deep, 55°.
Grotto del Cane, Italy, 68°.
Earth Yokutsk, 50 ft. deep, 18°.
Hecla Earth at Summit, 153°.
Geyser Springs, Iceland, 179°.
Thermal Spring, Tajurah and Shoa, 152°.
Thermal Spring, Island of Lucon, 174°.
Volcanic Mud, Jorullo, South America, 203°.
Ournastok Spring, Greenland, 103°.
Comagillas, Mexican Springs, 205°.
Eaux Bonnes, Pyrenees, 89°.
Aix-la-Chapelle Spring, Maximum Temperature, 180°.
Aix-la-Chapelle Spring, Spa, 143°.
Baden Baden Springs, Maximum Temperature, 157°.
Bagnères-de-Bigore Spring, 123°.
Mariana Springs, South America, 138°.
Wiesbaden Spa, 149°.
San Germano Bath, Naples, 181°.
Buxton Spring, 82°.
Matlock Spring, 66°.
Bristol Spa, 66°.
King's Bath, Bath, 114°.
Hot Pump, Bath, 116°.
Bath Springs, Maximum Temperature, 117°, supposed depth, 3,350 ft.
Monkwearmouth Mine, 1,500 ft. deep, 72°.
Consol Mine, Cornwall, 1,740 ft. deep, 93°.
Cumberland Coal Mine, 600 ft. deep, 66°.
Salt Mine, Cracow, 730 ft. deep, 50°.
Guanaxato Mines, 1,700 ft. deep, 99°.

† Prof. Everett, D.C.L., of Belfast.

MARINE THERMOMETERS.

FIG. 378.

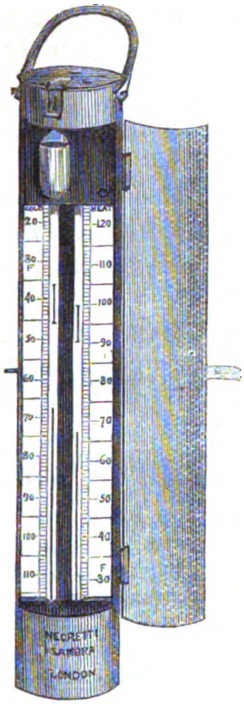


FIG. 379.

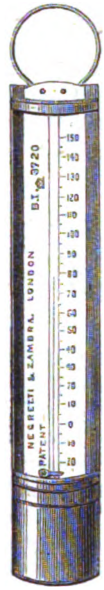


FIG. 375.

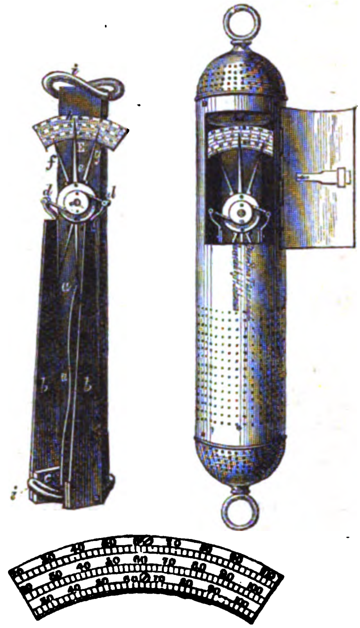


FIG. 377.

SELF-REGISTERING THERMOMETERS, ADAPTED FOR DEEP SEA SOUNDINGS.

		Each. £	s.	d.
374	**Board of Trade Marine Thermometer,** the scale divided on its stem, and mounted on Negretti and Zambra's PATENT PORCELAIN SCALES, in japanned metal case	0	10	6
375	Ditto ditto, in COPPER CASE (fig. 375)	0	12	6
376	**Board of Trade Marine Thermometer,** in round Copper case . .	1	10	0
377	**Johnson's Registering Metallic Marine Thermometer.** The indications are obtained by the varying expansion of brass and steel bars acting upon an index on the principle of the Thermostat (fig. 377). For full description see N. and Z.'s *Treatise on Meteorological Instruments* . . .	5	5	0
378	**Deep Sea Sounding Thermometers, Self-Registering,** the original *double tube principle,* as invented by Negretti and Zambra, specially constructed for and supplied to the Board of Trade and Admiralty (fig. 378), and used exclusively in all Deep Sea Sounding and Dredging expeditions. Warranted to stand a pressure of 450 atmospheres . . .	2	10	0

Many have been the contrivances for obtaining correct deep sea indications. Thermometers and machines of various sorts have been suggested, adopted, and eventually abandoned as only approximate instruments. The principal reason for such instruments failing to give correct or reliable indications has been that the weight or pressure at great depths has interfered with the correct reading of the Instrument. Thermometers have been enclosed in strong water-tight cases to resist the pressure; but this contrivance has only had the tendency to retard the action, so much as to throw a doubt on the indications obtained by the instrument so constructed.

The manner of protecting the bulb was invented by Messrs. Negretti and Zambra in 1857, and has been latterly copied by other persons and brought out as a new invention. This method of protecting the bulb is described by the late Admiral R. FitzRoy, in the first number of *Meteorological Papers,* p. 55, published July 5th, 1857, as follows:

"Referring to the erroneous readings of all thermometers, consequent on their delicate bulbs being compressed by the great pressure of the ocean, he says:—'With a view to obviate this failing Messrs. Negretti and Zambra undertook to make a case for the weak bulbs, which should transmit temperature, but resist pressure. Accordingly a tube of thick glass is sealed outside the delicate bulb, between which and the casing is a space all round, which is nearly filled with mercury. The small space not so filled is a vacuum, into which the mercury can be expanded, or forced by heat or mechanical compression, without doing injury to or even compressing the inner or much more delicate bulb.'"

The bulb of the Thermometer thus protected resists the pressure of the ocean, which varies according to its depth—that of three thousand fathoms being something like three tons pressure upon the square inch.

379 **Negretti and Zambra's Small Deep Sea Sounding Thermometer,** the so called Dr. Miller's pattern in Copper Case (as fig. 379). Price, £2 10s. £3 3s.

Both of the Deep Sea Sounding Thermometers (Nos. 378, 379) having been found defective in their indications, their use is not recommended for reasons stated in the following paragraphs.

NEGRETTI & ZAMBRA'S

NEW RECORDING DEEP-SEA THERMOMETER.†

380 This Thermometer differs from all other Registering or Recording Thermometers in the following important particulars:—I. The Thermometer contains only mercury, without any admixture of alcohol or other fluid. II. It has no indices or springs, and its indications are by the column of mercury only. III. It can be carried in any position, and cannot be put out of order except by actual breakage of the instrument. And lastly and chiefly, it will indicate and record the exact temperature at any depth of the sea, irrespective of either warm or cold currents or stratum through which the Thermometer may have passed in its descent or ascent. This last very special quality renders N. and Z.'s Thermometer superior for deep sea temperature to any others; for those used in the *Challenger* sounding expedition *are* liable to give erroneous indications, owing to their indices slipping, and otherwise getting defective (this was proved by Messrs. Negretti and Zambra at a Meeting of the British Meteorological Society); and *under certain conditions of temperature* it is not possible by the old Thermometers to obtain true temperatures at certain depths which might be required. *Annexed is a copy of a report to the Admiralty from Captain G. S. Nares, of H.M.S. Challenger, dated Melbourne, March 25th*, 1874.

"In the report to the Admiralty of Captain G. S. Nares, of H.M.S. *Challenger*, dated Melbourne, March 25th, 1874, Captain Nares, speaking of the temperature of the ocean, especially near the pack edge of the ice, says:—'At a short distance from the pack the surface water rose to 32°, but at a depth of 40 fathoms we always found the temperature to be 29°; this continued to 300 fathoms, the depth in which most of the icebergs float, after which there is a stratum of slightly warmer water of 33° or 34°. As the thermometers had to pass through these two belts of water before reaching the bottom, the indices registered those temperatures, and it was impossible to obtain the exact temperature of the bottom whilst near the ice, but the observations made in lower latitudes show that it is about 31°. More exact results could not have been obtained even had Mr. Siemen's apparatus been on board.' It seems to us that the difficulty mentioned is one which would certainly have been surmounted by Messrs. Negretti and Zambra's new Recording Thermometers."—*Nature, July 30th*, 1874.

Experiments are still being carried on by N. and Z. to reduce the size and simplify the mechanism of their Thermometer, of which particulars will be found in the Appendix.

† For further interesting particulars of the History, Construction, and Use of Deep Sea Registering Thermometers, see Appendix at the end of this Catalogue.

The construction of Negretti and Zambra's new Deep Sea Thermometer is as follows:—

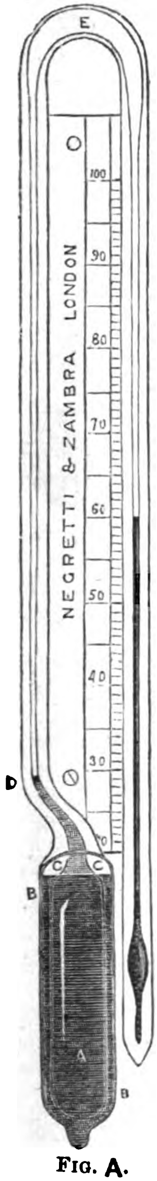


FIG. A.

In shape it is like a syphon with parallel legs, having a continuous communication, as seen in the annexed figure. The scale of the Thermometer is pivoted on a centre, and being attached in a perpendicular position to a simple apparatus (which will be presently described), is lowered to any depth in the water that may be desired. In its descent the Thermometer acts as an ordinary instrument, the mercury rising or falling according to the temperature of the stratum through which it passes; but so soon as the descent ceases, and a reverse motion is given to the line, so as to pull up the Thermometer towards the surface, the instrument turns once on its centre, first bulb uppermost, and afterwards bulb downwards. This causes the mercury, which was in the left-hand column, first to pass into the dilated syphon bend at the top, and thence into the right hand tube, where it remains, indicating on a graduated scale the exact temperature at the time it was turned over. Fig. A shows the position of the mercury *after* the instrument has been thus turned on its centre. A is the bulb; B *the outer coating or protecting cylinder;* C is *the space of rarefied air, which is reduced if the outer casing be compressed;* D is a small glass plug on the principle of Negretti and Zambra's Patent Maximum Thermometer, which cuts off, in the moment of turning, the mercury in the tube from that of the bulb, thereby insuring that none but the mercury in the tube can be transferred into the indicating column; E is an enlargement made in the bend so as to enable the mercury to pass quickly from one tube to another in revolving; and F is the indicating tube or Thermometer proper. In its action, as soon as the Thermometer is put in motion, and immediately the tube has acquired a slightly oblique position, the mercury breaks off at the point D, runs into the curved and enlarged portion E, and eventually falls into the tube F, when this tube resumes its original perpendicular position.

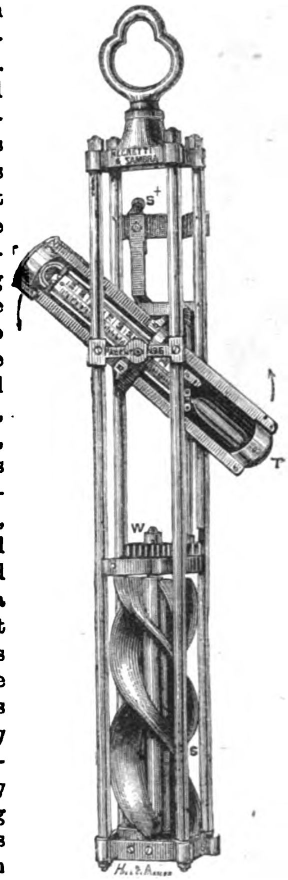


FIG. B.

The contrivance for turning the Thermometer over may be described as a frame with a vertical propeller; to this frame (fig. B) the instrument is attached. In its descent through the water the propeller is lifted out of gear and revolves freely on its axis; but so soon as the apparatus is pulled up towards the surface the propeller falls into gear and revolves in the contrary direction, turning the Thermometer over once, and then becoming locked and immovable, and records the temperature for that moment . . . . *Price,* £10 10 0

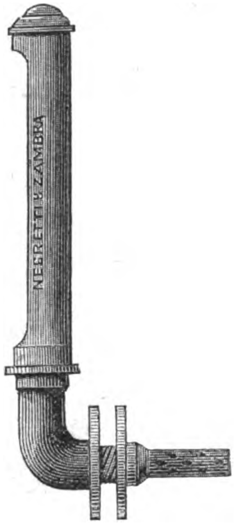


FIG. 385*.

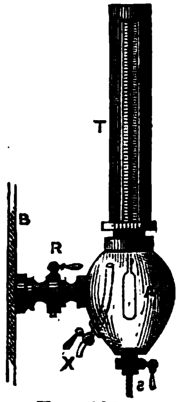


FIG. 387.

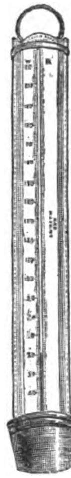


FIG. 375.

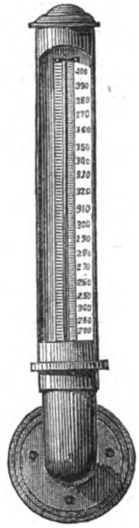


FIG. 385.

STEAM PRESSURE GAUGES.

The almost daily occurrence of frightful accidents from the explosion of steam boilers calls for the utmost vigilance and care from owners and employers of steam power. One of the most important precautions is that of having *accurate and reliable gauges.* Too much stress cannot be laid upon this point, for if, from motives of false economy, cheap and carelessly made gauges are used, their indications can never be depended upon, and their use may lead to fatal and costly results. It has frequently come under the notice of Messrs. Negretti and Zambra that steam gauges have been supplied or repaired by persons without the slightest knowledge of their construction, or having any means of proving or testing; consequently they have been found fearfully in error, and worse than useless because unsafe.

		£	s.	d.
380*	**Steam Gauges,** Mercurial, from 10 to 140 lbs., with union joint at either side of the frame, in polished Mahogany frame (fig. 380) .	2	2	0
381	Ditto, ditto, in japanned Iron ditto	2	10	0
382	Ditto, ditto, Brass ditto	3	3	0
383	**Thermometric Pressure Gauge,** for showing the pressure of vapour by taking its temperature (fig. 362), Iron mountings . . .	1	10	0
384	Ditto ditto, Brass mounting (figs. 354 and 355)	2	10	0
385	Ditto ditto, ditto *Bent tubes,* as figs. 385 and 385*, with screw flanges and stuffing boxes, &c., for high pressures from	3	3	0
386	**Thermometric Pressure Gauges** with temperature and pressure Scales made of any length to order or drawings, with either English or French divisions.			

387 **Negretti and Zambra's Saturometre or Thermometrical Salinometer** for determining the amount of salt held in solution in the water of Marine Boilers.

It is well known that pure water boils at 212° Fahr. at the level of the sea, and if water is impregnated with salt, the point of ebullition is materially raised; hence the water in a marine boiler can be accurately tested as to its saline properties by observing at what temperature the ebullition is taking place within the boiler. The apparatus consists of a metal reservoir attached to the boiler by a stopcock, R, and union joint, B; this reservoir carries a thermometer, T, whose bulb, A, reaches nearly to the bottom of the chamber; the graduations on the scale commence at 212°, the boiling point of pure water. At the bottom of the reservoir is an outlet tap, S, and there is also a tap, X, inserted a little above the bottom of the reservoir, with a tube connected with it reaching nearly to the top of the interior of the reservoir.

The apparatus is used as follows: the reservoir having been emptied by the tap S, it should be closed, and the taps R and X opened; the water from the boiler will then flow into the chamber A, partly fill it, and pass out by the pipe and tap X. After the water has been allowed to escape for a few seconds, the thermometer is to be examined, and according to the temperature indicated so will be the specific gravity of the water in the boiler, or, in other words, the percentage of salt dissolved in it. This fact is quickly and conveniently ascertained by simply opening three taps and reading the thermometer (fig. 387) £4 4 0

Our table in connection with the description and use of Salinometers (page 163) will give the relative degrees of saltness and temperature.

Messrs. Negretti and Zambra very strongly advise the use of the Thermometric Pressure Gauges (No. 384) in conjunction with the Mercurial and Spring Gauges as a comparative and precautionary measure of safety. When steam is generated and confined in a boiler, the pressure upon the boiling water may be twice or thrice that of the atmosphere. Experimentally it has been found, that if the pressure in the boiler be 25 lbs. on the square inch, the temperature of the boiling water, and of the steam likewise, is raised to 241°; and under the exhausted receiver of an air-pump, water will boil at 185°, when the pressure is reduced to 17 inches of mercury. The following table, compiled by Dr. A. S. Taylor, gives the relative temperatures and pressures up to 12 atmospheres or 180 lbs. pressure.

388

Water boils.		Barometer 30 inches.		Water boils.		Barometer 30 inches.	
212	degrees Fahr.	1	Atmosphere.	320	degrees Fahr.	6	Atmospheres.
234	”	1·5	”	327	”	6·5	”
251	”	2	”	332	”	7	”
267	”	2·5	”	337	”	7·5	”
275	”	3	”	342	”	8	”
285	”	3·5	”	351	”	9	”
295	”	4	”	359	”	10	”
300	”	4·5	”	368	”	11	”
307	”	5	”	374	”	12	”
315	”	5·5	”				

ON COMBINED STEAM. By the Hon. J. WETHERED.

“In its passage through the super-heating apparatus a portion of steam is raised by the waste heat to a temperature of 500° or 600° Fahrenheit. The heat thus arrested is conveyed to and utilised in the cylinders by its action on the other portion of the steam from the boiler, which is more or less saturated, according to circumstances. The combined steam is used in the cylinder at from 300° to 450° Fahrenheit, at which steam is generally employed. The effect of using the two kinds of steam is, that the super-heated steam yields a portion of its excess of temperature to the ordinary steam, converting the vesicular water which it always contains into steam, and expanding it several hundred-fold; whilst at the same time, the ordinary steam yields a portion of its excess of moisture, converting the steam gas into a highly rarefied elastic vapour—in other words, into pure steam at a high temperature.”

HYDROMETERS, &c.

Hydrometers, or Areometers, are instruments constructed to determine the specific gravity of fluids. Their use has been traced back to a date about 300 years before Christ, the invention being ascribed to Archimedes, the Sicilian philosopher. Their action is dependent upon the law "that a body immersed in any liquid sustains a pressure from below upwards equal to the weight of the volume of liquid displaced by such body."

First on our list of Hydrometers we place those showing *Specific Gravity*, because all other Hydrometer scales are referable to it; and as the figures indicated are absolute and definite quantities, or values without possibility of dispute, it is the best both for scientific and manufacturing purposes.

The Specific Gravity of Fluids may be simply described in a few words.

A very light glass flask is accurately adjusted and stoppered to hold exactly 1,000 grains of pure distilled water at a temperature of 60° Fahrenheit. If this flask be filled with highly rectified æther, and then carefully weighed in a delicate balance, it will be found that the flask instead of holding 1000 grains will only weigh say 713 or 715 grains at 60 degrees of temperature. This is the specific gravity of pure æther, or as written in chemical language, 0·713 or 0·715. On the contrary, if the flask be filled with concentrated sulphuric acid it will be found to hold 184·2 or 184·5 grains, or specific gravity, 1·842 or 1·845, at 60 degrees temperature. In these readings water is represented by one thousand, or 1·000.

All other fluids (save Mercury) will be found to be of intermediate specific gravity, say between 600 and 2·000.

Our list embraces the whole of the Hydrometers in use in the United Kingdom and most of the foreign instruments. The comparative value of these may be ascertained by reference to a valuable series of carefully compiled tables described at No. 401, end of Hydrometer Section.

As a rule all Hydrometers made in England are adjusted to a temperature of 60° Fahrenheit, but if they are required for use in the East or West Indies, they must be specially adjusted at 84° Fahrenheit, and should be ordered accordingly.

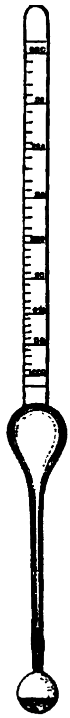


FIG. 393.

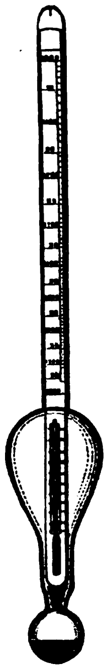


FIG. 452.

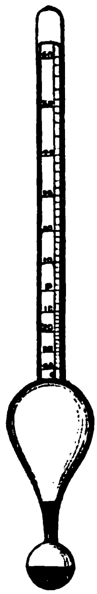


FIG. 397.


FIG. 396.

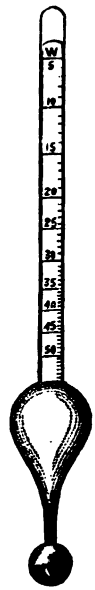


FIG. 408.

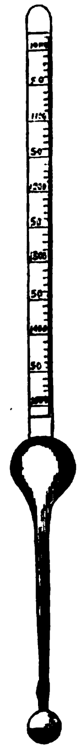


FIG. 394.

		Each. £ s. d.	Each £ s. d.
393	**Hydrometer** from 700 to 1·000 for **Specific Gravities** lighter than water (fig. 393)		0 6 6
394	**Hydrometer** from 1·000 to 1·850 or 2·000, for fluids heavier than water (fig. 394)		0 6 6
395	**Beaume's Hydrometer** ·0 to ·70, for fluids lighter than water		0 5 0
396	Ditto **Hydrometer**, ·0 to ·40, for cane-juice and similar fluids heavier than water (fig. 396) . .		0 5 0
396*	**Beaume's Saccharometer**, brass gilt, for sugar boiling, range ·0, ·40		1 7 6

Beaume's Hydrometers are used extensively in England as well as in France, and are applicable for testing all kinds of liquids.

There are two distinct instruments, one for fluids lighter than water, and the other for fluids heavier than water.

The latter is for distinction called the Acidometer or Saccharometer (*pèse-acide* or *pèse-sirop*), the former the Spirit Hydrometer (*pèse-esprit*).

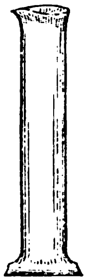


FIG. 398*.

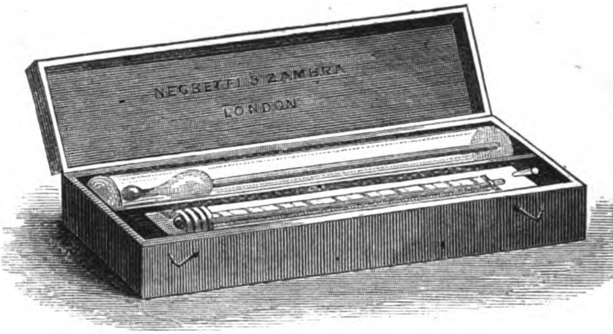


FIG. 398.

		£	s.	d.
397	**Sikes' Hydrometer, glass** (Government Proof), showing percentages of proof spirit from 60 over proof to 40 under proof (fig. 397).	0	5	6
398	**Sikes' Hydrometer, glass,** in **mahogany box** with thermometer (fig. 398)	0	15	0
399	Ditto ditto, with ivory sliding computing scale	1	1	0

400 **Sikes'* Hydrometer** is the instrument used by the government officers in the collection of the spirit revenue in the United Kingdom. It is made entirely of metal, usually strongly gilt to prevent corrosion.

It consists of a globular float with an upper and lower stem. The upper stem is flattened and divided into ten parts, numbered 1, 2, 3, &c. These are again subdivided into five parts.

The lower stem is tapering, and terminated by a pear-shaped bulb. There are nine weights numbered from 10 to 90, each weight being pierced in the centre, so that it can be placed on the conical stem at the smaller end and slid down towards the bulb until it becomes securely fastened.

401 **Sikes' Hydrometer** is adjusted to spirit specific gravity ·825 at 60° Fahr., this being considered *Standard Alcohol.* In this spirit the instrument floats at the first division 0 on the stem without a weight. In weaker spirit, having a greater density, the Hydrometer will not sink so low, and should the density be greater, one of the weights must be added to cause the entire immersion of the bulb of the instrument.

Each weight represents so many principal divisions of the stem. Thus the heaviest weight, marked 90, is equal to ninety divisions of the stem, and the instrument with this weight attached floats at 0 in distilled water.

Each principal division on the stem being divided into five, the Hydrometer has a range of 500 degrees between alcohol, sp. gr. ·825, and water.

On one side of the upper stem, near to the division 1, will be found a line, at which the instrument will float with the weight 60 attached in spirit exactly of the *strength of proof* at a temperature of 51° Fahr., and if the *square* weight (sent with the instrument) be placed on the top of the stem, the weight 60 still being attached to the lower stem, the instrument will float at the side line in distilled water of the same temperature. This square weight being precisely one-twelfth part of the total weight of the hydrometer and weight 60, the above indication is in conformity with the definition of *proof spirit* stated in the act of parliament, "Proof spirit to weigh at 51° temperature exactly twelve-thirteenth parts of an equal bulk of distilled water."

In using Sikes' Hydrometer, it is immersed in the spirit and pressed down to 0 until the whole of the divided stem be wet. The amount of force required to

* We have consulted several authorities for the correct spelling of this name; Dr. Ure and Professor Redwood spell it *Sikes*. An act of parliament, 26th June, 1858, 18 and 19 Vict., has *Sykes*—many writers adopt this. The same difference occurs with the name of the inventor of a Maximum and Minimum Registering Thermometer—*Six* or *Sixe*. In both cases there appears to be some doubt which is correct.

FIG. 402*.

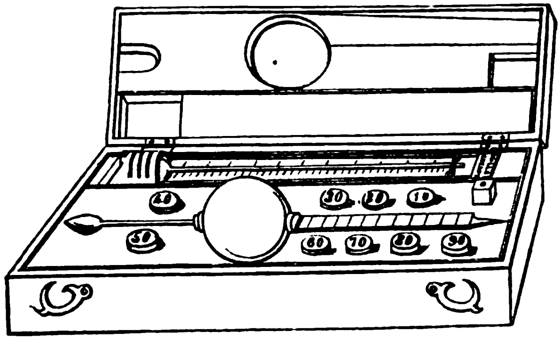


FIG. 402.

sink it will determine the selection of the requisite weight to be attached to the lower stem. Again immerse the hydrometer in the spirit, and allow it to float freely and settle, and then keeping the eye in a line with the surface of the spirit, notice the division cut by the surface as seen from below. The number indicated by the stem is added to the numbers of the weight, and the sum of these, together with temperature of the spirit (which should be very carefully noted) will, by reference to a Book of Tables accompanying the instrument, give the required strength per cent. of the spirit under test.

The strength is expressed in numbers denoting the excess or deficiency per cent. of proof spirit in any sample, and the number itself having its decimal point removed two places to the left, becomes a factor, whereby the gauged contents of a cask of such spirit being multiplied, and the product being added to the gauged contents if *over* proof, or deducted from it if *under* proof, the result will be the actual quantity of proof spirit contained in such vessel.

The commercial term *above or below proof* is partly derived from the government having fixed a certain strength of spirit as mentioned above as *Proof Spirit*, by which the strength of all spirit is comparable. It is also said that the term *proof* is derived from an ancient method of testing the strength of spirit by pouring the sample over gunpowder in a metal cup and then setting fire to the spirit; if, when the spirit had burnt away, the powder exploded, the spirit was said to be *over proof;* if, on the other hand, the gunpowder did not ignite, owing to the large portion of water left behind it was said to be *under proof.*

The weakest spirit capable of firing gunpowder by this method was called proof spirit, but it requires a spirit of nearly the strength of what is now called rectified spirit to stand this test.

The *Standard Proof Spirit* of the excise is defined by law (56 Geo. III. cap. 140) to be "*that which at a temperature of* 51° *Fahrenheit's Thermometer, weighs exactly twelve-thirteenth parts of an equal measure of distilled water.*"

This will have a specific gravity of ·923 at 51° Fahrenheit, or about ·920 at 60° Fahrenheit.

The *Standard Alcohol* of the Excise is spirit of the specific gravity ·825 at 60° Fahrenheit. By "Spirit 60 degrees over proof" is understood a spirit 100 measures of which added to 60 measures of water will form *Standard Proof Spirit*, specific gravity ·920.

By "Spirit 10 degrees under proof" is understood a spirit 100 measures of which mixed with 10 measures of standard alcohol, specific gravity ·825, will form *Standard Proof Spirit.*

NOTE.—We are indebted to Professor Redwood for most of the figures given in connection with Sikes' Hydrometer. The *British Pharmacopœia* of 1864 orders that the Specific Gravity of liquids is to be taken at a temperature of 60 degrees by Fahrenheit's Thermometer, and gives the Specific Gravity o absolute Alcohol as 0·795, *Rectified Spirit* (Spiritus Rectificatus) as 0·838, and *Proof Spirit* (Spiritus Tenuior) as 0·920, at a temperature of 60 degrees Fahrenheit.

No.		£	s.	d.
		Each.		
402	**Sikes' Hydrometer,** Double Gilt Metal, with silver soldered joints, as used by the Excise and Customs, with weights, enamel tube Thermometer, Test Glass, and Book of Tables (fig. 402 and 402°)	4	0	0
403	Ditto ditto, with Comparative Rules	4	10	0
	Book of Tables to 80° Fahr.	0	10	6
	Ditto ditto 100° Fahr.	0	12	6
	Book of Tables for use with Sikes' Hydrometer to 80° Fahr.	0	10	6
	Ditto ditto ditto to 100° Fahr.	0	12	6
404	**Sikes' Pocket Hydrometer** in German Silver	0	15	0
405	Ditto with Thermometer, jar, and case	1	10	0
406	**Sikes' Hydrometer** Standard, 5-inch range on stem, divided to 1-10ths	5	5	0

Saccharometer for Brewers' use. Shows the weight of wort per barrel heavier than water. Thus 36 gallons of water weighs 360 lbs., but 36 gallons of wort of specific gravity 1·050, weighs 18 lbs. heavier than water, *viz.*, 378 lbs.

Printed instructions for use accompany each Saccharometer.

No.		£	s.	d.
407	**Dicas's and Allan's Hydrometers** are very similar in construction to Sikes' instrument, but are now very rarely used.			
408	**Brewers' Saccharometer** Glass, showing pounds per barrel (fig. 408)	0	5	6
409	Ditto ditto with extra scale showing specific gravity and lbs. per barrel	0	7	6
410	Ditto ditto in mahogany box, with thermometer as fig. 398.	0	15	0
411	**Saccharometer's Glass** Standard, comprising two instruments in mahogany case, one Saccharometer ranging from 0 to 25 lbs , and the other 25 lbs. to 50 lbs., very carefully adjusted	2	2	0

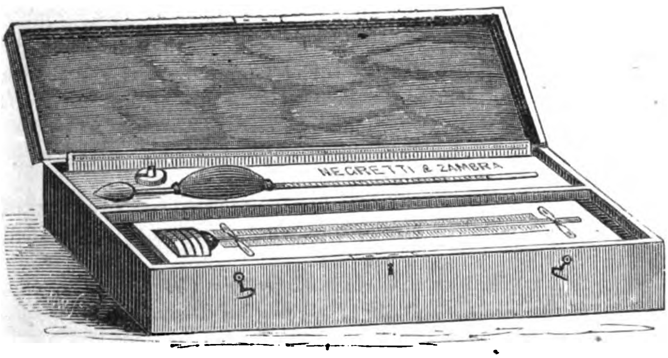


FIG. 412.

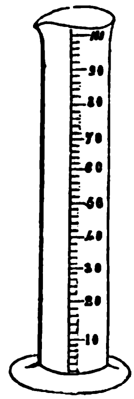


FIG. 412*.

No.		£	s.	d.
412	**Double Gilt Metal Saccharometer,** with silver soldered joints, with one weight, metal scale, enamel tube, compared Thermometer, with expansion scale and rule, in mahogany case, with lock and key, glass assay jar (figs. 412 and 412°), and book of directions for use	5	0	0

This Saccharometer can be strongly recommended both for strict accuracy and the very highest class of workmanship.

The improved Saccharometer has a scale extending from water to 25 lbs. per barrel on one side of the upper stem, and by the use of the weight, the opposite scale will test wort from 25 lbs. to 52 lbs. per barrel.

No.	Description	Each. £	s.	d.	Each. £	s.	d.
412°	Ditto, ditto, plainer mounted, including Thermometer, rule, and book of instructions, in box				4	0	0
412°*	Ditto ditto not Gilt				3	3	0
413	**Combined Glass Hydrometer and Saccharometer,** 2 Scales showing Specific Gravity and lbs. per barrel, with Thermometer, in mahogany case				2	2	0
414	**Saccharometer Thermometer,** with enamelled tube and expansion scale, mounted on Silvered Brass Scale .				0	14	0
415	**Saccharometer Can,** for testing wort, Copper, tinned inside				0	10	6
416	Ditto, ditto Tin japanned				0	4	0
417	**Glass Saccharometer testing or sample jars** (fig. 417)	0	2	6	0	3	6
417*	**Graduated Glass Blending Jars,** for wine, spirits, or beer (figs. 417* and 417**) . . . . . 4s. 6d.	0	5	6	0	7	6
418	**Small Glass Hydrometer,** specific gravity scale, with sample glass and thermometer in case (figs. 418 & 418*)				0	15	0

Small Glass Hydrometers in Pocket cases of various scales and range made to order.


FIG. 424*.

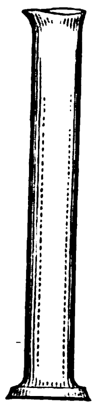


FIG. 417.

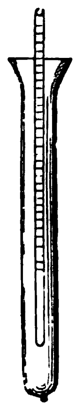


FIG. 453.

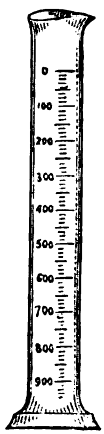


FIG. 417*.

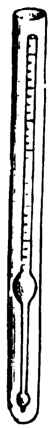


FIG. 453*.

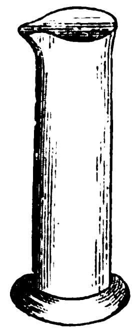


FIG. 417**.


FIG. 425.

No.	Description	£	s.	d.
419	Small Glass Hydrometers, two in the set, Specific Gravity Scale, from water to sulphuric æther, or from water to sulphuric acid, in neat case with thermometer and test jar	1	10	0
420	Sets of eight small Glass Hydrometers, specific gravity, full range from æther to sulphuric acid, with thermometer and sample jar in case	3	10	0
421	**Twaddell's Hydrometers,** Nos. 1, 2, 3 . . . . . . each	0	3	6
422	Ditto ditto, Nos. 4, 5, and 6 . . . . do.	0	4	0
423	**Set of six Twaddell's Hydrometers,** in mahogany case, with Thermometer graduated on the stem, and test glass	2	2	0

424 **Twaddell's Hydrometers,** so named after their inventor, Mr. Twaddell of Glasgow, are very largely used by Dyers, Bleachers, and Paper manufacturers, the six instruments having an extended or very open scale, figured from 0, water, to 170 about the gravity of the strongest sulphuric acid. Each degree or division of Twaddell's scale being equal to five degrees of specific gravity.

Comparative Scale showing the values of Twaddle's Hydrometers, Nos. 1 to 6, in Specific Gravity.

No.	Twaddle's Scale.	Specific Gravity.
1	0 to 25	1·000 to 1·125.
2	25 „ 50	1·125 „ 1·250.
3	50 „ 75	1·250 „ 1·375.
4	75 „ 100	1·375 „ 1·500.
5	100 „ 125	1·500 „ 1·675.
6	135 „ 170	1·675 „ 1·850.

Twaddle's Hydrometers if for use in hot climates are specially tested and adjusted at 84° Fahrenheit at an extra cost of 6d. on each instrument.

	£	s.	d.
424* **Aquarium Hydrometer,** for showing the density of salt or sea-water (fig. 424*)	0	3	6
425 **Board of Trade Marine Hydrometers,** for taking the specific gravity of sea water ·0 to ·40 (fig. 425)	0	5	6
425* Ditto ditto, 2 Hydrometers with very open scale, 0 to 40° and 20 to 40°	0	10	0

Sea Water ranges in Specific Gravity from 1·020 to 1·036, the ordinary gravity varying between 1·026 to 1·028. Mediterranean Sea Water about 1·030, and that of the Caribbean Sea, 1·040. The water of the Dead Sea has the extraordinary density of 1·200 to 1·250, the saltest water known.

The Saltness of Sea-Water.—Professor Chapman, of University College, Toronto, says that the object of the saltness of sea-water is to regulate evaporation. If any temporary cause raises the amount of saline matter in the sea to more than its normal value, evaporation goes on more and more slowly. If the value be depreciated by the addition of fresh water in undue excess, the evaporation power is the more increased. He gives the results of various experiments in reference to evaporation on weighed quantities of ordinary rain-water and water holding in solution 2·6 per cent of salt. The excess of loss of the rain-water compared with the salt solution was, for the first twenty-four hours, 0·54 per cent., at the close of forty-eight hours, 1·46 per cent.; and so on in an increasing ratio.

Analysis of sea-water taken from the English Channel:—

Chloride of Sodium	1891·6
Chloride of Magnesium	228·4
Chloride of Potassium	47·8
Iodide and Bromide of Magnesium . . .	15·4
Sulphate of Magnesia	145·4
Sulphate of Lime	94·5
Grains per gallon .	2423·1

These quantities vary with the locality as well as the percentage of Organic Matter also found in Sea Water.

The ordinary surface temperature of the sea in temperate climates is 45° to 51·5° Fahrt.

"In most parts of the world the average temperature of the ocean's superficial water is nearly that of the air upon its surface. In the tropics the temperature of the sea water ranges from 70° to 80° Fahr. or more, and the air is much the same. In some limited parts of the globe the surface water is as warm as 86°, for instance, near the Galapagos Islands;

and in some very confined localities even *more than* 90°, as for example in parts of the Red Sea and Indian Archipelago. But although so warm on the surface it is very much colder at a few hundred fathoms below, the temperature decreasing to 35°, and even less."

			£	s.	d.
426	**Universal Hydrometer**, for all fluids from ·700 to 1·900		0	12	0
427	**Confectioners' Hydrometer** for Ice making	3s. 6d. and	0	5	6
428	Ditto ditto for Syrups (see also No. 396)		0	5	6
429	**Hydrometer** for Brine. A saturated solution of sea salt varies between 1·1962 and 1·205 at 60° Fahrenheit		0	5	6
430	**Hydrometer** for British Wines (Roberts' scale, 0 to 26°)		0	5	6
431	Ditto, for Syrups (Specific Gravity)		0	5	6
432	Ditto, for Soap (Beaumé's)		0	5	6
433	Ditto, for Soap Lye (Specific Gravity)		0	5	6
440	**Oleometer**, for fixed oils, such as Sperm, Linseed, Rape, &c.		0	5	6

From a competent authority we quote the following gravities:—

Linseed Oil	0·9347	Olive Oil	0·9176
Almond Oil	0·9180	Rape Seed Oil	0·9136
Castor Oil	0·9611	Colza Oil	0·9136
Palm Oil	0·968	Nut Oil	0·9260
Oil of Turpentine	0·870	Whale Oil	0·923

		£	s.	d.
434	**Acidometer**, for estimating the strength of Acids (fig. 394)	0	6	6
435	**Acetometer** (or Acetimeter), for **Vinegar**	0	6	6

"Specific Gravity if determined by a Sensitive Hydrometer is a good test of the strength of genuine vinegar. The following table of Messrs. Taylor is nearly correct, or sufficiently so, for commercial transactions.

"Revenue Proof Vinegar, called by the English manufacturer No. 24, has a Specific Gravity of

1·0085, and contains of real acid in 100	5
1·0170 " " "	10
1·0257 " " "	15
1·0320 " " "	20
1·0470 " " "	30
1·0580 " " "	40

DR. URE."

It should be observed that all Malt Vinegars contain mucilage, gluten, or saline particles, which would, to a certain extent, veil the indications of the Hydrometer; therefore, if precise accuracy be required, recourse must be had to Chemical Tests such as will be found described in all modern Chemical Books.

		£	s.	d.
436	**Barktrometer Glass** for Tanners' use, from 0 to 50	0	7	6
437	Ditto ditto, 0 to 80, divided to ½ degrees	0	10	6
438	**Barktrometer Gilt Metal**, 0 to 80, divided to ½ degrees, with Thermometer, in Mahogany Box	3	3	0
439	**Citrometer**, for lime or lemon juice, as used by the Commissioners of Customs, specific gravity scale from 0 to 100 in two instruments for greater accuracy, complete with computing rule, and a delicate thermometer in a case	1	16	0

Like Vinegar, Lime or Lemon Juice often contains a very large percentage of mucilage, so that the indications of the Citrometer should only be regarded as approximate and not absolute. We also find that by the Act of Parliament August 26th, 1867, 30 & 31 Vict., cap. 124, Lime or Lemon Juice for ship's use *is to contain "fifteen per centum of proper and palatable proof spirits."* Chemical Tests must therefore be resorted to where definite results are desired.

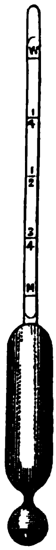
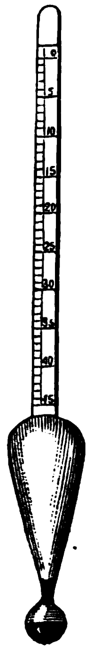
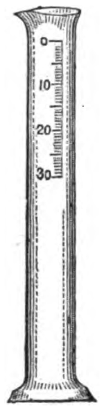
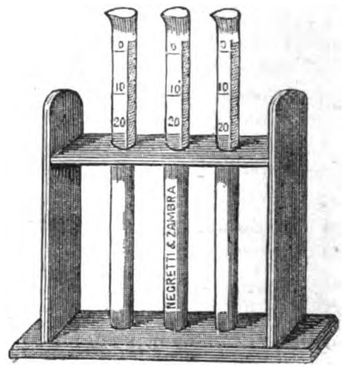






FIG. 448. FIG. 441. FIG. 443. FIG. 445*. FIG. 445.

NEGRETTI AND ZAMBRA'S LACTOMETERS FOR ASCERTAINING THE DIFFERENT QUALITIES OF MILK.

IT is a matter of great importance in rural and domestic economy that we have a ready means of ascertaining the Quality of Milk yielded by different cows. The richness of milk depending upon the quantity of *oil or butter*, and *curd or cheese* which it contains, it becomes necessary that we be able to determine these quantities with facility and precision.

To attain these ends, Messrs. NEGRETTI & ZAMBRA have introduced a simple form of Lactometer, by which the richness of milk may be determined by simply taking its *temperature* and *specific gravity*.

The Lactometer consists of a glass ball and stem, containing a graduated scale ranging from 0° (water) to 40° specific gravity, *adjusted to a temperature of* 60° Fahrenheit. A glass jar and thermometer usually accompany the instrument.

441 **Lactometer** of a simple form for household use. The top of the scale is marked O and W, indicating water, and at the lower end P signifying pure milk. Intermediate between these two points are marks indicating $\frac{1}{4}$ milk and $\frac{3}{4}$ water, $\frac{1}{2}$ milk and $\frac{1}{2}$ water, $\frac{3}{4}$ milk and $\frac{1}{4}$ water. These marks must not be taken as absolute, for pure milk will vary in quality or density according to the particular kind of food upon which the cows have been feeding (fig. 441) £0 3 6

442 **Lactometer** similar to above but with an additional scale showing specific gravity £0 5 0

443 **Lactometer,** Negretti and Zambra's, Lactometer of superior accuracy, with absolute specific gravity scale, with printed instructions for use (fig. 443) £0 5 0

No.		Each. £ s. d.
444	**Lactometer Tubes**, or Creamo-meters, graduated to show the percentage of cream; a set of six in mahogany frame	0 16 0
445	Ditto, a set of three tubes in frame (fig. 445)	0 10 6
445°	**Cream Test Jars**, graduated to show percentage (fig. 445°)	0 5 6
446	**Thermometer**, add or subtract, for use with above. (See also Dairy Thermometers)	0 7 6
447	**Lactometer Glass**, with **Thermometer and Test Jar**, in **Mahogany** Box (as fig. 398)	1 10 0
448	**Thermometers** for Dairy Use, entirely mounted in glass (fig. 448)	3s. 6d. 5s. 6d.
449	**Lactometer, Gilt Metal**, Specific Gravity Scale	1 5 0
450	Ditto ditto Gilt Metal, with **Thermometer** and Test Jar, in mahogany Box (as fig. 398)	2 2 0
451	**Centesimal Galactometer, Glass** (Dr. Hassall's)	0 10 6

Lactometers being adjusted to a temperature of 60° Fahr., all trials must be made at that temperature. Should, however, that be inconvenient, then for every five degrees of difference in temperature, make a difference of one degree on the Lactometer scale, adding the degrees of temperature if above 60°, and subtracting them if below 60°. For greater convenience, Thermometers are made by NEGRETTI and ZAMBRA to show at a glance the amount to *add* or *subtract* for difference of temperature.

FROM EXPERIMENTS MADE, IT IS FOUND THAT THE SPECIFIC GRAVITY INDICATED BY THE LACTOMETER SHOULD BE AS FOLLOWS:

For Cows' Milk	26 to 38
„ Cows' do. (grass-fed) before being creamed	— — 32
„ Cow's milk (grass-fed) the cream being taken off	— — 38
Woman's ditto	28 — 38
„ Ass's ditto	30 — 34
For Goat's do. (house-fed)	30 — 34
„ Milk of Ewes (grass-fed) before being creamed	— — 36
„ Ditto ditto, the cream being removed	— — 46
„ Mare's milk	— — 36

DR. HASSALL.

No.		£ s. d.
452	**Negretti and Zambra's Hydrometer**, with Thermometer in the stem, for showing density and temperature in one instrument (fig. 452)	1 10 0
453	**Sheeffer's** Hydrometers, one from ·700 to 1000, the other from 1000 to 1·900 with solution tube, per pair (figs. 453 and and 453*)	0 15 0
454	**Cartier's Hydrometer**, chiefly used in France for testing fluids lighter than water. It is a modification of Baumé's spirit hydrometer, the same point being taken as the zero of the scales. The space which in Baumé's scale is divided into 32°, is in Cartier's divided into 30°	0 6 0
455	**Gay Lussac's Alcohometer or Hydrometer**, for testing the strength of spirits—mostly used in France. The scale is divided into 100 parts, the lowest division, marked 0 at the bottom of the scale, denotes the specific gravity of pure water at a temperature of 15° Cent. or 59 Fahr. The highest division at the top of the scale indicates the specific gravity of absolute alcohol of sp. gr. ·796 at the same temperature. The intermediate degrees indicate the number of volumes of such alcohol in 100 volumes of the spirit tried	0 6 0

FIG. 464.

FIG. 465*.

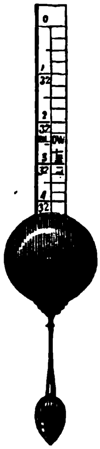


FIG. 466.

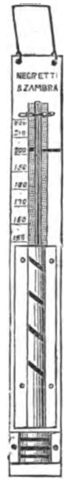


FIG. 469.

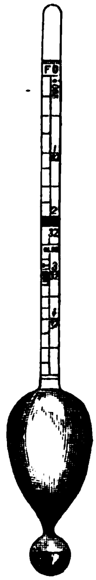


FIG. 465.

		Each £	s.	d.
462	**Paraffin or Petroleum Hydrometers,** Specific Gravity scale . . .	0	6	6
463	Ditto ditto, **Standard**	0	10	6
464†	**Paraffin Thermometers,** fig. 465* and see ante No. 297 page 137 .	0	5	0
464	**Paraffin Testing Apparatus,** Government pattern, complete with thermometer and spirit lamp (fig. 464)	0	15	0

Fig. 464 shows the Government form of apparatus for testing Petroleum to ascertain the temperature at which it gives off inflammable vapour. It consists of a small sheet-iron vessel to hold the Petroleum to be tested; this is placed in an outer vessel to hold water (somewhat in the manner of an ordinary gluepot) with a metal cylindrical support, so arranged that the water can be gradually heated by a spirit lamp, and the temperature of the Petroleum conveniently observed by a Thermometer specially constructed for the purpose, as ordered by Act of Parliament 34 & 35 Vict., cap. 105, August 21st, 1871, Schedule I., in which minute instructions are given as to the construction and use of the apparatus.

The Report of the Select Committee on the Petroleum Bill of 1872 contains the following: "It is very generally admitted that the Standard fixed by the existing Act for the flashing point of Petroleum, *viz.*, 100 degrees Fahrenheit in the open test, is sufficiently high to guarantee the safety of the public."

PROFESSOR REDWOOD.

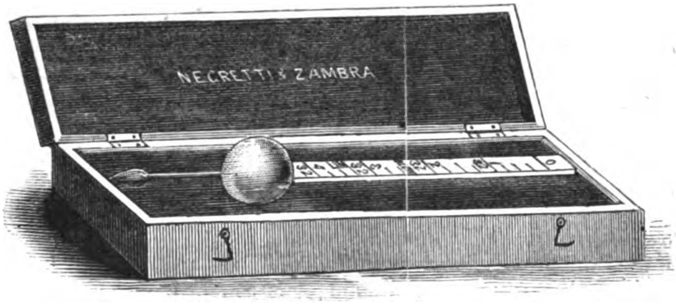


FIG. 467.

		Each. £ s. d.	Each. £ s. d.
465	**Salinometer, Glass,** for ascertaining the density of salt water in steam boilers, to prevent incrustation (fig 465.)	0 5 6	
466	Ditto ditto, **gilt metal,** in tin case (fig. 466)		1 5 0
467	Ditto ditto, **Gilt Metal or German Silver** in Box, fig. 467		1 5 0
468	Ditto with **Thermometer** in mahogany box . . .		1 15 6
469	**Salinometer Thermometer** (fig. 469)		0 6 6
470	Ditto, **Testing Pot Stout Copper,** with division for Thermometer		0 8 6
471	**Hydrometer Test Glasses,** or **Jars,** on foot (fig. 417*), 2s.	0 3 6	0 5 6

The Salinometer used for testing the density of water in Marine Steam Boilers has a scale with five principal divisions marked upon it, the first division on the top of the stem is marked 0, representing pure water, the others marked $\frac{1}{32}$ $\frac{2}{32}$ $\frac{3}{32}$ and $\frac{4}{32}$ signify that when the Salinometer floats at any of these divisions, that the water contains 1, 2, 3, or 4 parts of saline or solid matter in 32 of water.

Between $\frac{2}{32}$ and $\frac{3}{32}$ is engraved the word *Blow*, indicating that when the Boiler Water has reached that density, a portion of it should be blown out of the boiler and replaced with fresh water. The temperature at which the water is to be tested is 200° Fahr.

At the $\frac{3}{32}$ word "**Limit**" is marked, when, at that indication, it becomes dangerous to work it beyond that strength or density.

Thus, this Instrument purports to indicate the precise time at which Marine Steam Boilers should be blown off, not only to prevent waste by blowing off too frequently, but to avoid the possibility of the Boiler being injured by the deposition or incrustation of the salt, which is a bad conductor of heat, and frequently the cause of the Boiler being burst. The engineer, by merely looking at the scale of the Salinometer as it floats in the water, can at once ascertain the saline density of the water with the greatest accuracy.

TO USE THE SALINOMETER.

Fill the Assay Jar from the Boiler, suspend the Thermometer in the side partition of it, and immerse the Ball in the water; then at whatever division on the stem it rests level with the surface, will be the degrees of saline matter contained in the water at the temperature of 200°; but if the heat of the water varies below that degree, the following scale of temperature will be the blowing-off points:—

$$\text{TEMPERATURE.}\quad \left.\begin{array}{l} 200^\circ\ \frac{2}{32} \\ 180^\circ\ \frac{2\frac{1}{4}}{32} \\ 160^\circ\ \frac{2\frac{1}{2}}{32} \end{array}\right\}\ \text{at surface for blowing-off point.}$$

Under the circumstances at which fresh water boils at 212°, sea water boils at 213·2°. The boiling temperature is raised by the chemical solution of any substance in the water, increasing with amount of matter dissolved. For this reason, marine engineers use a thermometer to determine the amount of salts held in solution by the water in the boilers of sea-going steamers. Common sea water contains about $\frac{1}{33}$ of its volume of salt and other earthy matters. As evaporation proceeds, the solution becomes proportionally stronger, and more heat is required to produce steam. The following table by Messrs. Main and Brown, shows the relation between the boiling point under the mean pressure of the atmosphere, or 30 inches of mercury, and the proportion of matter dissolved in the water.

When the salts in solution amount to $\frac{12}{33}$, the water is saturated. It has also been ascertained that, when a solution of $\frac{4}{33}$ is attained, incrustation of the substances commences on the boiler. Hence, it is a rule with engineers to expel some of the saturated water, when the thermometer indicates a temperature of 216° F, and replace it with fresh water, in order to prevent incrustation and injury to the boiler.

The boiling point of *Saturated* Solution of Salt varies from 218 degrees to 226 Fahr.

472†	Proportion of Salt in	100 parts of water	0	. .	Boiling point	212°
	"	"	$\frac{1}{33}$	. .	"	213·2
	"	"	$\frac{2}{33}$	. .	"	214·4
	"	"	$\frac{3}{33}$	. .	"	215·5
	"	"	$\frac{4}{33}$	. .	"	216·6
	"	"	$\frac{5}{33}$	. .	"	217·9
	"	"	$\frac{6}{33}$	. .	"	219·0
	"	"	$\frac{7}{33}$	. .	"	220·2
	"	"	$\frac{8}{33}$	. .	"	221·4
	"	"	$\frac{9}{33}$	. .	"	222·5
	"	"	$\frac{10}{33}$	. .	"	223·7
	"	"	$\frac{11}{33}$	. .	"	224·9
	"	"	$\frac{12}{33}$	. .	"	226·0

For further information on this subject, see Temperature Thermometer in conjunction with Pressure Gauges, page 151.

472† **Salinometer (How's Patent),** constructed of strong Gun Metal and Brass, for attaching to the Boilers of Marine Steam Ships, to ascertain at any moment the specific gravity of the water contained in the Boiler. Complete, with Metal Salinometer, Thermometer, and Lamp; best finished Gun metal Tap Unions and Valves. £10 0 0

Spirit Gravity Beads are small light hollow spheres made of white or coloured glass about half-an inch in diameter, with a stem or tail of about a quarter of an inch in length. The use of this stem is for adjusting each bead to a certain degree of Specific Gravity, or to a given degree of Sike's Hydrometer Scale. The degrees are engraved upon each Bead, thus forming them into rough Hydrometers for ascertaining the Gravity of various Fluids or Spirits. When the Bead floats about half way in any sample of liquid to be tested, the density or specific gravity of such liquid is indicated by the figures or numbers engraved upon the bubble.

473 **Salt Water Beads,** or bubbles, for Aquaria . . . in pairs 0 2 0

The average Specific Gravity of Sea Water is 1·026 to 1·028.

Gravity Beads for Aquaria are made of different coloured glass, one adjusted to float upon the surface of the water, and the other to remain at the bottom of the tank when the water is of suitable density for the healthy growth of fish or plants.

No.	Article	£	s.	d.
473*	**Specific Gravity Beads** (or Spirit Bubbles, Glasgow Beads), for showing the strength of spirits, set of twelve, in japanned tin box	0	6	6
474	Ditto, ditto . . . . set of eighteen	0	10	6
475	**Specific Gravity Beads,** for heavy and light fluids, such as ether, alcohol, ammonia, oil, naphtha, acids, each .	0	1	0
476	**Specific Gravity Bottles,** 1,000 grains' capacity, in tin case with counterpoise weight. (See also Chemical Section.)	0	10	6
477	Ditto ditto 500 grains	0	8	6
478	Ditto ditto 250 grains	0	6	6
481	**Nicholson's Gravimeter,** for ascertaining the specific gravity of metals or other solid substances, of japanned tin (fig. 481)	0	10	0
482	**Nicholson's Gravimeter,** larger size, accurately made in BRASS, fitted in case, with weights ranging from 1-10th to 1,000 grains (fig. 482)	3	0	0

FIG. 481.

FIG. 482.

Nicholson's Hydrometer or Gravimeter is a modification of Fahrenheit's instrument, and is made either of very light tin japanned, or gilt brass; its form will be seen in fig. 481. A mark is made on the stem supporting the cup to which the instrument is adjusted by weight to float in water. The weight of the loaded instrument when sunk to this point is *the weight of the volume of liquid displaced by it.* It gives, therefore, the relative weights of equal volumes of the liquids into which it is placed. The Gravimeter is usually made to displace 3,000 or 4,000 grains of water, and is sensible to the tenth of a grain in this quantity. With this instrument, the specific gravity of *solids* may also be ascertained. By placing the solid to be tested in the cup on the top of the stem and adjusting the additional weights required to sink the Hydrometer, the weight of such solid body *in air* is found. Then by placing the solid in the *lower* cup immersed in the water, and again adjusting the weights as before, the weight of the solid in *water* is ascertained; and from these two results the specific gravity is calculated.

DIRECTIONS FOR USING NICHOLSON'S GRAVIMETER.

To find the specific gravity of a mineral or other solid, place weights in the upper cup sufficient to sink the Hydrometer to the mark on the stem when the Hydrometer is floated in distilled water, and call this weight A. Now take a piece of mineral, *of less weight than* A; place this in the upper cup, and add weights until the Hydrometer sinks to the same mark as before. Call the weights added B. Remove the solid from the upper cup to the lower, allowing the weights to remain in the upper cup. Add weights until the Hydrometer sinks to the mark on the stem, and call the additional weights C. Subtract B from A, and divide the remainder by C, and the quotient is the specific gravity.

Thus, suppose the specific gravity of a specimen of fluor-spar is required. First, on trial, we find that 460 grains placed in the upper cup will sink the Hydrometer to the mark on the stem when floated in distilled water—consequently, A is equal to 460 grains; and that when the fluor-spar is placed in the upper cup, 92 grains must be added to sink the

Hydrometer to the same level as before—then B is equal to 92 grains. Now, on removing the fluor-spar to the lower cup, 115 grains must be added to the 92 grains still remaining in the upper cup to sink the Hydrometer to the same mark as before; therefore C is equal to 115 grains. Then

```
      460
       92
115)368(3·2
     345
      230
      230
```

Consequently, 3·2 is the specific gravity required.

In our Chemical Section will be found and described Balances arranged to exhibit the same facts with extreme precision.

479 **Fahrenheit's Hydrometer** has two glass bulbs blown on a tube similar to the ordinary hydrometer, the upper bulb being the larger. The top of the stem is terminated by a small cup or dish. The lower bulb is weighted with mercury sufficient to cause the partial immersion of the instrument when placed in water without any weights being placed in this cup. In the middle of the stem is a mark, to which point the hydrometer is adjusted in water by placing weights in the cup. Its use is similar to that of Nicholson's Gravimeter. 0 10 6

480 **Densimetre,** a modification of Fahrenheit's instrument, chiefly made and used in France and other parts of the continent 0 12 6 1 5 0

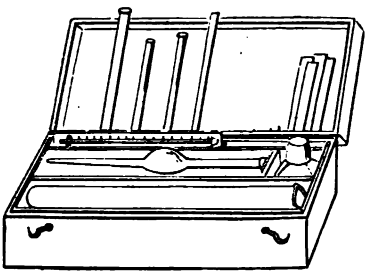


FIG. 486.

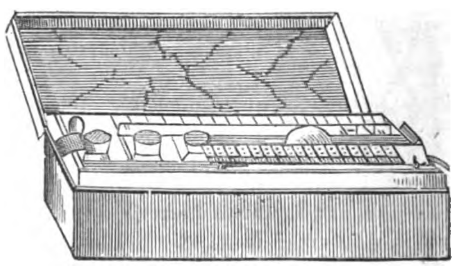


FIG. 486*.

		£	s.	d.
483	**Urinometer,** for ascertaining the specific gravity of urine, of two forms, fig. 483 and 483*	0	3	6
484	Ditto, ditto, in round leather pull-off case, with graduated test glass	0	6	6
485	Ditto ditto, in leather case with hinges	0	7	6
	Ditto ditto, with test glass and thermometer	0	12	6
486	Ditto, ditto, in **Leather case,** handsomely fitted up with thermometer, spirit lamp, acid bottle, test glasses, dropping tube, graduated jar, test papers, &c. (fig. 486)	1	10	0
		£	s.	d.
486*	**Urinometer,** larger case, and more complete, with extra stoppered and cut test bottles and evaporating dishes, tube holder, &c. (fig. 486*)	2	2	0
487	**Metal Urinometer, Gilt or Plated,** in pull-off case	0	18	0
488	**Urinometer Test Papers** . . . . per book	0	0	2

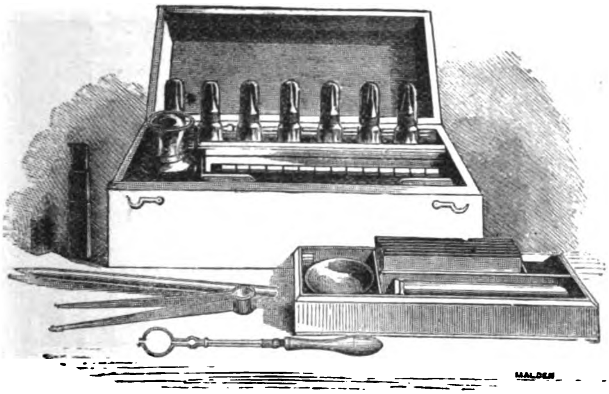


FIG. 489.

FIG. 483. FIG. 483*. FIG. 489*.

The Urinometer originally suggested by Dr. Prout for ascertaining the density of urine has a scale divided into 60 degrees, the zero being the point at which the instrument floats in distilled water at a temperature of 60° Fahrenheit.

The numbers on the scale added to 1,000 (the assumed specific gravity of water) give the specific gravities at the respective points. If the number cut by the surface of the fluid under test be 30, it indicates a specific gravity of 1·030. On the reverse side of this scale will be found the letter W at the top, on the same line as the 0 indicating water. Lower down the scale is a space marked H, signifying *healthy standard,* which ranges from 10° to 20° of the scale. The space from 30° to 60° is marked *diabetes,* the urine of diabetic patients generally ranging between these points. See figs. 483 and 483*.

489 **Dr. Lionel Beale's Clinical Cabinet** arranged as a companion to Dr. Beale's work, *The Microscope in its Application to Urinary Analysis, &c., &c.*

CONTENTS:—Urinometer in sheath, 2 oz. graduated measure, glass pipette, stirring rod, test tubes, watch glasses, glass slips, and thin glass covers, glass spirit lamp, test tubes, holder, test papers, 8 improved capped dropping bottles (fig. 489) in ebonite rack, for containing the following re-agents, acetic acid, nitric acid, ammonia, potash, nitrate of barytes, nitrate of silver, oxalate of ammonia, &c. (fig. 489*) . 2 5 0

489† **Urea Tubes** divided to 100ths of a cubic inch 0 7 6
489° **Improved Droppin** fig. 489° 0 1 6

FIG. 493.

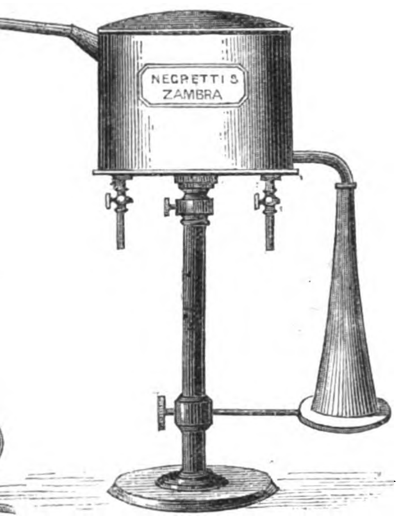


FIG. 492.

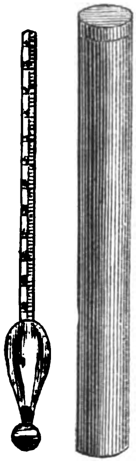


FIG. 494.

FIG. 495*.

490 **Alcoholometer, Field's Patent,** for ascertaining the original gravity of every description of **ale, stout,** or **porter,** at any period after fermentation. This apparatus is useful for testing comparatively various samples of beer, returned beer, and also beer for export. Price, complete in mahogany box, with directions for use, and correction tables of variation £6 0 0

491 **Wine or Spirit Analyser, Long's Patent,** for ascertaining the quantity of alcohol in wines, cordials, &c., in accordance with Treasury Order of July 12, 1853, fixing the maximum of spirit in wine at 33 per cent. £4 10 0

Graduated Glass measure standard for use with above . . . £0 3 6

492 **Distilling Apparatus; or, Phillips' Revenue Standard Still,** for ascertaining the original gravity of Beer after fermentation, &c.; of strong brazed copper, with two Trial Jars and Thermometer, Pipette or Dropping Tube, &c. (fig. 492) £5 5 0

This apparatus is also used for the **Alcoholic Wine Test** by the Board of Customs for estimating the amount of Alcohol contained in Wines and Liqueurs.

493 **Gas Burner,** improved for above (fig. 493) £0 12 6

494 **Gilt Metal Hydrometer,** pocket size, for use with above apparatus, in neat case (fig. 494) £0 16 0

495 **Gilt Metal Saccharometer,** pocket size for ditto in case . . . £0 16 0

495* **Glass Flasks for Still,** with metal screw fittings £0 4 0

Sikes' Hydrometers, for use in connection with the above, see page 154.

METHOD OF USING THE DISTILLING APPARATUS.

Attach the water supply, which may be a Cistern or Cask placed four feet above the Condenser, the connection being by Flexible Tube from the Tap of the Cistern; the outflow of water is to be conducted into a pail, the quantity used being regulated by the Cock in the Cistern; and the water having been found to flow through the Condenser in a continuous stream, the Gas Lamp should be connected also by means of Flexible Tube, with a Gas Pipe, and lighted on the top of the Gauze. Where Gas is not obtainable, a large Spirit Lamp can be used.

To Test a Sample of Wine.—Fill the Measure Flask with Wine to the highest mark, adjusting the exact quantity by using the Pipette; pour the measured Wine into the Still Flask, rinsing out the Measure with a few drops of water which must be added to the Wine; the measure being quite clean, is placed upon the bracket, and adjusted to receive the Distilled Wine Spirit; the Still Flask is then to be screwed tightly to the Condenser, interposing an Indiarubber Washer between the Flask and the metal shoulder of the Still Pipe; put the Lamp under the Still Flask, at first moderately burning, afterwards increase the flame; in a few minutes the Wine will boil, and the vaporised Spirit will begin to condense, falling into the Measure. Repeated experiments have proved that with weak Wines, such as contain under 26 per cent. of Proof Spirit, it is only necessary to distil over one-half the bulk; but stronger Wines, containing much extractive matter, require the operation to be continued until two-thirds are distilled; the Standard Measure is therefore graduated at two-thirds as well as one-half. When the required point on the Measure is obtained, the original measure of the Wine (up to the highest mark) is to be made up with Water, then poured into the Trial Glass and stirred well, so that the Spirit and Water may be perfectly mixed with the Thermometer; the temperature should be observed, being the strength taken by Sikes' Hydrometer according to the usual tables.

To insure extreme accuracy, it is necessary that the temperatures of the Wine before distillation, and the Spirit and Water before taking the strength by the Hydrometer, should be the same, that the two bulks may be identical.

Accurate Balances and Weights, Specific Gravity Bottles, Test Jars, Graduated Measuring Glasses, &c., &c., for use with the Distilling Apparatus. See sections "Thermometers," "Hydrometers," and "Chemical Apparatus."

495† **Negretti and Zambra's Patent Strengthened Glass Hydrometer,** fig. 495†. Of all glass instruments required by the exigencies of Science, the Glass Hydrometer is the most delicate and fragile. Very many of these instruments are broken in carriage, and very recently the Government for India requiring a large number of Hydrometers for fiscal purposes, applied to Messrs. Negretti and Zambra for assistance in producing an Hydrometer which could be safely sent to the interior of India. Messrs. Negretti and Zambra submitted some instruments, which so far fulfilled the conditions required, that 20,000 of Messrs. Negretti and Zambra's Patent Hydrometers were ordered and supplied. The novelty consists in inserting an inner tube down the stem, and reaching to the bottom, and there being fastened securely to the neck of the lower bulb; it will be seen that by these means the weight of the instrument is supported from the bottom, and not at the juncture of the stem with the large bulb, where usually the breakage of the old form of Glass Hydrometers took place.

Any form of Hydrometer described in the preceding pages can be constructed with Negretti and Zambra's improvement *to order* at a slightly increased expense.

		£	s.	d.
456	**Richter's and Tralle's Hydrometer**, with Thermometer	0	15	6
457	**Normal Alcoholometer**, Tralle's, chiefly used in Prussia and the United States, has a scale figured from 0° to 100°, each degree representing one per cent. by volume of Alcohol, Specific Gravity 0·7939 in any mixture of Alcohol and Water at 60 degrees temperature Fahrenheit	0	13	6
458	**Volumeter** (Gay Lussac's), for liquids lighter or heavier than water	0	6	6
458*	**Wooley's Hydrometer.** This instrument has 2 scales, *viz.*, Government Proof and Specific Gravity	0	6	6
458A	A set of five **Standard Glass Hydrometers.** Government Proof Scale, forty under Proof to sixty over proof, with a very accurate Thermometer in a Mahogany Box, with Book of Tables as used with the metal Hydrometer	4	0	0
458B	**Hermbstadt's Hydrometer and Saccharometer,** having two Scales, one showing Specific Gravity, 1·000 to 1·321 and percentage of Sugar 0 to 67	0	6	6
459	**Densimetre** (Gay Lussac's), for liquids lighter or heavier than water, in two spindles simple form	0	8	
460	Ditto (Rousseau), for ditto ditto ditto	0	8	6
461	**Photographic Hydrometer,** or Argentometer, showing grains per ounce of nitrate of silver in solution	0	3	6

496 **Comparative Scales** (Baker's), compiled from tables of eminent authorities, for the use of Chemists, Distillers, Brewers, Dyers, Bleachers, Paper makers, British Wine makers, Confectioners, &c., &c.

It comprises Specific Gravity Scale, Twaddell's, Baumés, Cartier's, Gay Lussac, Saccharometer scale of lbs. weight per barrel, Extract per barrel, and the Government Proof spirit scale. Several percentage scales for Spirits, Acids, Chlorine, Ammonia, Solutions of Potash, Soda, and four comparative Thermometer Scales; *viz.*, De Lisle, Centigrade or Celsius, Fahrenheit, and Reaumur,—in all 34 scales, containing a vast amount of most valuable and useful information. Price 2s. each.

Recent Acts of Parliament in connection with the adulterations of food, drugs, &c., &c., will often necessitate strict investigation; in such matters, therefore, Messrs. Negretti and Zambra cannot too strongly impress upon the minds of their customers the great importance of accuracy in all apparatus used for analysing or testing the purity or strength of the articles under examination.

For such purposes, N. & Z., from their great experience in this special branch of their trade, can confidently recommend their instruments.

The various **Areometers**, &c., &c., used on the Continent to ascertain the density of Liquids, made to order.

GAUGING INSTRUMENTS, RULES, &c. *See Scales and Rules.*

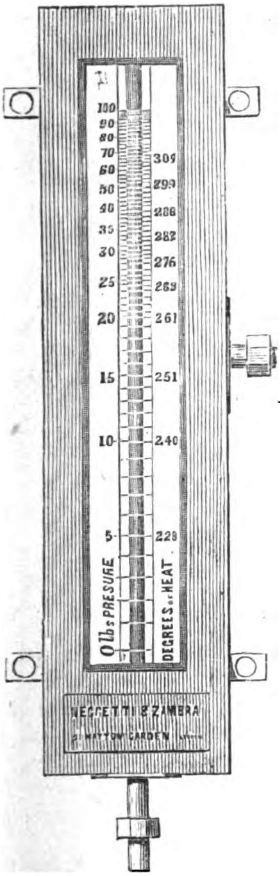


FIG. 499.

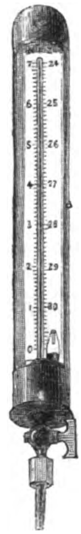


FIG. 500.

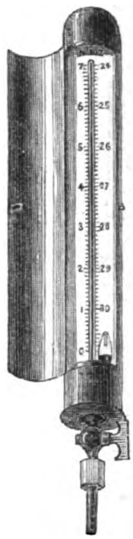


FIG. 501.

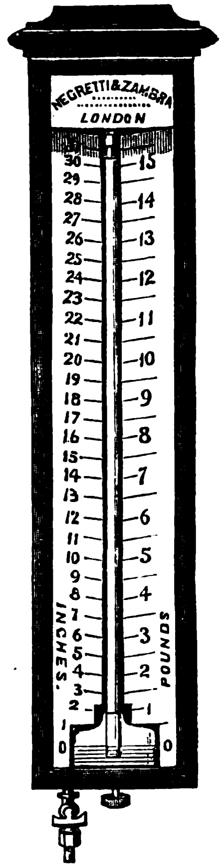
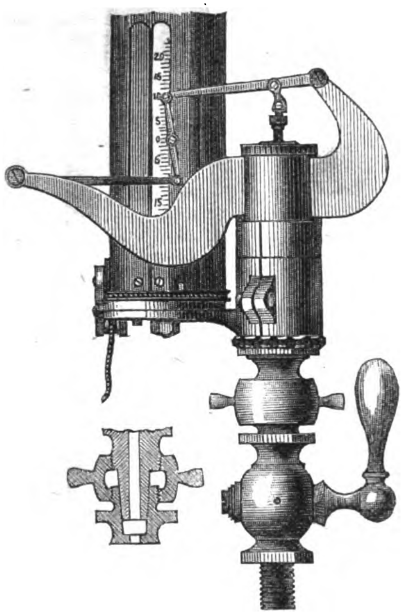


FIG. 502.

MERCURIAL VACUUM GAUGES.

		£	s.	d.
497	**Vacuum Gauge,** in Mahogany or Oak frame, for general purposes .	2	2	0
498	Ditto . . . . . ditto in Plain Brass frame.	2	10	6
499	**Marine Vacuum Gauge,** in oak frame, iron cistern, stout glass tube, gun metal unions, and PATENT PORCELAIN SCALES, divided to 1-100th of an inch (fig. 499)	4	4	0
500	**Vacuum Gauge.** The tube and scale are enclosed in stout glass cylinder and brass frame, with stop-cock and union (fig. 500) .	1	10	0
501	**Sugar Pan Vacuum Gauge,** as above, in Brass case, with hinged door, ground plug, fitting with stop-cock, &c. (fig. 501) . . .	2	10	0
502	**Vacuum Gauge,** to show 30 inches, in handsome mahogany case, with plate glass front, adjusting glass cistern, Gun Metal Tap, &c., suited for First-class Engine Rooms (fig. 502).	5	5	0

For Circular Vacuum Gauges, see **Bourdon's Gauges,** *pages* 180 *to* 182.



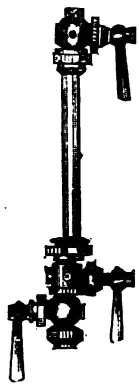


FIG. 509.

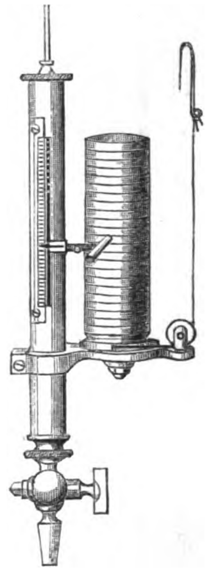


FIG. 506.

FIG. 504.

		£	s.	d.
504	**Steam Engine Indicator,** in *gun metal,* for ascertaining the amount of power exerted during any part of the stroke, low pressure (fig. 504)	5	5	0
505	Ditto ditto **high pressure**	6	6	0
506	**Richards' Indicator with one Spring** (fitted with Darke's Patent Detent and Cord Adjuster) fig. 506.	8	10	0
507	**Extra Springs** ten varying scales . each	0	10	0
508	**Paper Cylinder Spring**	0	1	6
508A	**Arrangement for Oscillating Engines**	0	10	0
508B	**Metallic Paper** per packet	0	4	0
508C	**Treatise on Indicator** . New Edition	0	9	0
508D	**Extra Stop Cock**	0	8	0

508E **A 3-way Cock** for taking diagrams from top and bottom of cylinders without shifting the **Indicator** made to order. Connecting Pipes made to order. Elbow for attaching the **Indicator** to horizontal engines made to order.

Reducing Gears, for reducing the stroke of the Engine down to that of the Indicator.

Small size with Pulleys for strokes varying from 4 ft. 6 in. down to 1 ft. 6 in., price £4 17s. 6d., can be attached direct to the Indicator.

Larger size for strokes from 6 ft. down to 1 ft. 6 in., £5 17s. 6d.

These instruments are packed in mahogany cases with their necessary attachments.

	£	s.	d.
Old Indicators (Richards'), fitted with Detent at	1	10	0
Patent Cord Adjusters	0	5	6

GUN METAL WATER GAUGES.

509 On an improved principle, with ebony handle spanners, complete with glass tube and vulcanised rubber rings :—fig. 509.

$\frac{3}{8}$-in. 30s. $\frac{1}{2}$-in. 35s. $\frac{5}{8}$-in. 40s. $\frac{3}{4}$-in. 42s,

GAUGE TUBES.

503 **Gauge Tube,** for Steam Boilers, &c., of stout annealed glass, manufactured expressly for this purpose. Various lengths and diameters cut to order, average 1d. per inch

GAUGE TUBES of the best quality :—

SIZES.	PER DOZ. s.	d.	SIZES.	PER DOZ. s.	d.	SIZES.	PER DOZ. s.	d.
10 by $\frac{7}{16}$	7	0	10 by $\frac{5}{8}$	8	6	13 by $\frac{3}{4}$	12	0
12 „ $\frac{7}{16}$	7	6	12 „ $\frac{5}{8}$	9	0	14 „ $\frac{3}{4}$	12	6
10 „ $\frac{1}{2}$	7	6	13 „ $\frac{5}{8}$	10	0	15 „ $\frac{3}{4}$	13	0
12 „ $\frac{1}{2}$	8	0	14 „ $\frac{5}{8}$	10	6	16 „ $\frac{7}{8}$	17	0
14 „ $\frac{1}{2}$	8	6	15 „ $\frac{5}{8}$	10	6	18 „ $\frac{7}{8}$	18	0
10 „ $\frac{9}{16}$	9	0	16 „ $\frac{5}{8}$	11	0	16 „ 1	23	0
12 „ $\frac{9}{16}$	9	6	12 „ $\frac{3}{4}$	11	6	18 „ 1	25	0
14 „ $\frac{9}{16}$	10	0						

Estimates given for large quantities. India Rubber Washers for Packing Water Gauges.

GAS PRESSURE GAUGES.

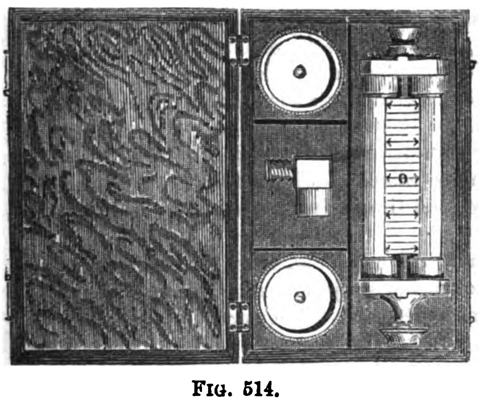


FIG. 514.

FIG. 512.

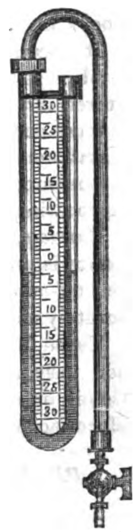


FIG. 513.

		£	s.	d.
510	**Gas Pressure Gauge,** with 6-inch glass syphon, wood scale divided to inches and tenths, and brass mountings	0	4	6
511	Ditto ditto, with **Stopcock**	0	7	6
512	Ditto, with Ivory scale and Stopcock (fig. 512), best finish	0	12	6
513	**Gas Pressure Gauge,** large size (fig. 513), with Stopcock and Union	1	5	6
513*	Ditto, of superior finish, as supplied to the Metropolitan Board of Works, in Brass Mountings, with stopcock	1	10	0
514	**Gas Inspector's Gauge,** with fittings complete, in leather pocket case (fig. 514)	2	2	0

COUNTING, TALLYING, MEASURING, AND REGISTERING MACHINES, OR ENGINE COUNTERS.

FIG. 515.

515 **Patent Automatic Counting Machine, Rivington and Gilbert's** (fig. 515) **for Printing-presses and Machines.**—This Machine counts and shows the exact number of newspapers, sheets, cards, or pieces printed. Being made with a *stop*, they do *not commence counting* till the machine is printing *good* sheets, nor when any machine is struck out, so that *double or treble rolling* can be obtained with single cylinder machines, and only *the correct number* of sheets printed will be registered. The *lever* working the machine can be *removed* by the machine-minder or overseer at night or meal times in *five seconds*, thus preventing any *tampering* with the Register by boys or others.

It *prevents the work being smeared* by the hand of any one passing over it while the ink is still quite damp, *saves the time occupied* in counting after the number required is printed; and as it counts each sheet when printed, it *saves paper* should any ream contain more than its proper number of sheets, or marks the deficiency if the stationer has sent in less than the full number, and it registers the revolutions and the motion of machines of all descriptions, whether rotary, oscillating, or reciprocating, and registers from 100,000 to 100,000,000.

Carriages.—It measures accurately the distance a carriage runs as fast as the distance is made. If necessary, a signal is attached which strikes at the end of each half-mile, enabling a person to drive and time a fast horse on any good road as accurately as on a race-course.

These Machines are simple, compact, and complete, with but few parts, and made very strong, not liable to be broken nor subject to much wear. They need little oil or attention, but if properly attached, and left entirely alone, they will perform accurately for years.

PRICES FOR COUNTING MACHINE.—FIG. 515, WITH WOODEN CASE.

	£	s.	d.
To count 100,000	1	5	0
„ 1,000,000	1	10	0
Machine, with brass case	4	0	0

(*With Lock, 2s. 6d. extra.*) Larger sizes in proportion, if required.

516 **Schaeffer's Improved Engine Counter,** for counting Oscillating motion, Reciprocating Strokes, or Revolutions in machines.

	£	s.	d.
4 figures, counts up to 10,000	2	13	6
5 „ „ 100,000	3	0	0
6 „ „ 1,000,000	3	7	6
7 „ „ 10,000,000	3	15	0

FIG. C.

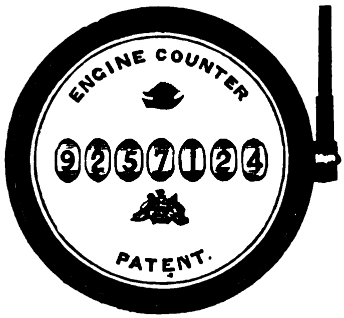


FIG. A.

HARDINGS PATENT CIRCULAR DIAL ENGINE COUNTER.

The ease with which the record of these Counters can at any time be read off is a great advantage which they possess over all *dial* counters (such as those on water and gas meters), in the difficult reading of which important errors are often made.

Other advantages of these Counters are,—great simplicity of parts and solidity of construction, in consequence of which it is almost impossible for the apparatus to get out of order.

It consists in an ingenious combination of wheels and pinions. Each number wheel carries on the right edge of its rim twenty teeth, and on the left edge only two. The pinions are provided with eight unequal teeth, four being as broad and four half as broad as the pinion. Thus, as each number wheel completes its revolution, it moves the next one on one-tenth, and all the wheels are safely locked, except at the moment when they are being moved forward by their pinions. Some idea of the perfection of this arrangement may be gathered from the fact that the Pocket Counter or Speedometer, of which the mechanism is a mere reduction of that of the large Counters, may be used at speeds over 5,000 per minute.

PRICE LIST FOR CIRCULAR ENGINE COUNTERS.

		£	s.	d.
No. (A)	**Large Engine Counter,** 7 figures, to count to ten millions, with rotary or reciprocating motion, and arranged so as to readily set back to zero (fig. A)	5	5	0
No. (B)	**Small Machine Counters** (with rotary action only), with 6 figures	2	2	0
	Ditto ditto with 4 figures	1	10	0
No. (C)	**Pocket Counter or Speedometer** (plated, and in handsome case), with 4 figures, and steel friction bits (fig. C)	2	12	6
No. (D)	**Turnstile Counters,** 5 figures	2	0	0

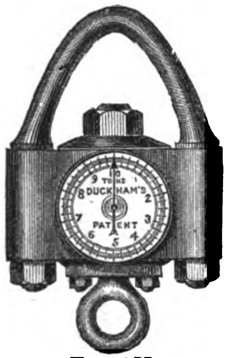


FIG. 517.

517 **Duckham's Patent Suspended and Self-Acting Weighing Machines and Dynamometers,** adapted to the Standards of all nations.

They are entirely self-acting, and indicate the weight of even the most ponderous goods, during the ordinary operation of loading or unloading.

They combine extreme simplicity and unlimited power with general utility, accuracy, low price, and economy in working.

They are invaluable to MERCHANTS, SHIPPERS, DOCK AND RAILWAY COMPANIES, as a ready and costless means of ascertaining the weight of merchandise in transit; to IRONMASTERS, that they may ascertain the weight of material even during the process of manufacture; to CHAIN, WIRE, AND ROPE MANUFACTURERS AND PURCHASERS, that the strength as well as the weight of such material may be proved; to SHIP OWNERS, that the weight of cargo and stores may be checked by the simple operation of lifting the same on board; to ENGINEERS, BOILER-MAKERS, HARD-WOOD MERCHANTS; and in fact, to ALL and any who deal with goods by weight, or are interested in knowing the strength of materials or machinery, that the goods may be weighed, and strains and strengths tested, by a process which is entirely free of expense.

"The inventor provides an open-top cylinder, which is filled with water or oil, and fitted with a piston and pressure gauge. For the purpose of weighing goods the cylinder is slung from an ordinary crane hook. The goods are attached to the piston rod, and immediately these are lifted as in process of loading or unloading ships or wagons the weight is denoted on the dial. *Nothing can be more simple.*"—*Mechanic's Magazine.*

PRESENT PRICES FOR PATENT SUSPENDED WEIGHING MACHINE.

				£	s.	d.
10 cwt. to 3 tons capacity,		45	lbs. weight	17	17	0
5 tons	ditto	56	„	24	0	0
10 tons	ditto	85	„	30	0	9
30 tons	ditto	280	„	50	0	0

517* **Hearson's Strophometer, or Revolution Indicator.** This Instrument indicates, by means of a pointer on a marked dial, the number of revolutions per minute an Engine is, at the time, revolving.

It is so designed that when Engines are subject to incessant momentary fluctations of speed, the needle points steadily at a number expressing the mean velocity.

It will be found particularly useful for Locomotives (the dial being graduated in miles per hour), for Spinning Machinery, and for Ships.

The Instrument is worked by means of a rope passing round a pulley on the shaft of the Engine, or in connection with a friction roller against a coupling of the shaft.

For description of the Instrument see paper read at the Institute of Naval Architects, and published in the Transactions for 1874, and also article in No. 4 Annual of Royal School of Naval Architecture.

PRESENT PRICES.

		£	s.	d.
Strophometer with 9-inch Dial		10	10	0
Leading Pulleys for ditto		0	3	6
Connecting Arrangement for ditto	from	2	10	0

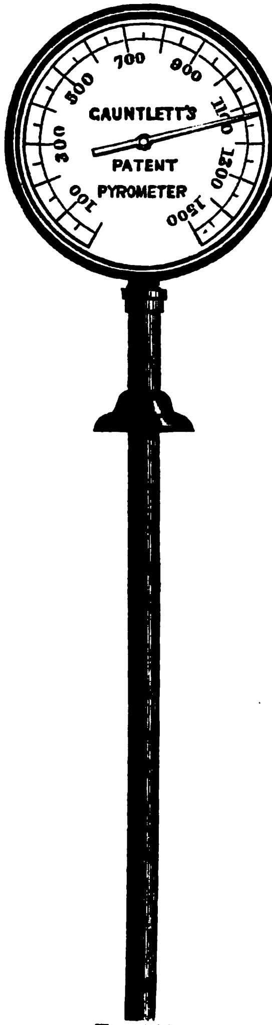


FIG. 518.

PYROMETERS.

	£	s.	d.
518 **Gauntlett's Pyrometer.**—This Pyrometer is constructed of metal bars expanding in a different ratio upon the application of heat, by which can be ascertained temperatures above the range of the mercurial thermometer. Its form is that of a long tube, surmounted by a dial with an index or pointer to indicate to 300° for fluids, or to 1,000° for furnaces, ovens, &c. (fig. 518)	4	4	0
519 **Chronometrical Pyrometer Thermometer** (Gauntlett's), with 8-day time-piece to indicate to 300° or 1,000°	8	10	0
520 **Daniell's Pyrometer,** for indicating high temperatures, such as the melting point of metals, temperature of furnaces, &c., by the expansion of a bar of platinum enclosed in a black lead cylinder, and measured by an index arranged with a spring and lever, to show upon a divided arc very small changes .	5	5	0
521 **Wedgwood's** ditto, for the same purpose, by the expansion of a cylinder of earthenware	5	5	0
522 **Ferguson's** ditto, for showing the difference of expansion in metals, suited for the lecture table as an experimental instrument .	5	5	0

523 **Hydro-Pyrometer,** Captain O. Byström's (Swedish Artillery), for ascertaining the heat of furnaces, &c. A ball of platinum, or other metal, is arranged upon a metal rod in such a manner that it can be inserted into the furnace to be tested, and when heated equal to the temperature of the furnace quickly withdrawn and dropped into a given quantity of water. By observing the temperature of the water before and after the above-mentioned procedure, the difference obtained will be the value or amount of heat of the furnace. Fitted up to order.

Further details respecting Pyrometers will be given in our section on Chemical Apparatus.

SIEMENS' WATER PYROMETER.

Fig 1.

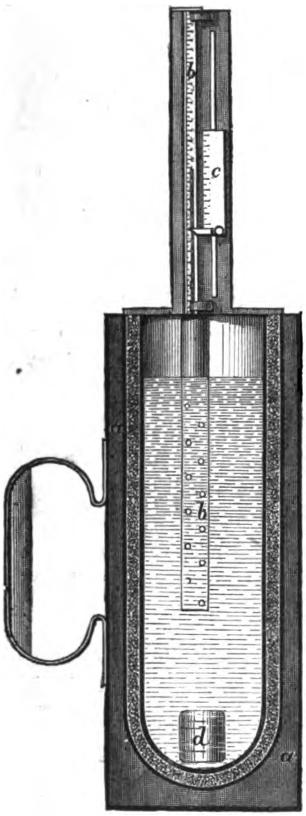
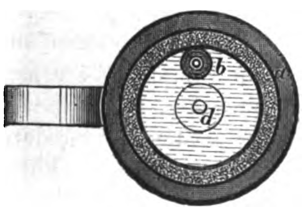


Fig. 2.



The PYROMETER is shown in figs. 1 and 2 in margin (fig. 1 being a vertical, and fig. 2 a horizontal section), and consists of a copper vessel capable of holding rather more than a pint of water, and well protected against radiation by having its sides and bottom composed of a double casing, the inner compartment of which is filled with felt. A mercury thermometer, *b*, is fixed in it, having, in addition to the ordinary scale, a small sliding scale *c*, graduated and figured with 50 degrees to 1 degree of the thermometer scale; 6 solid copper cylinders are provided with the Pyrometer, each accurately adjusted in size, so that its total capacity for absorbing heat shall be 1-50th that of a pint of water.

In using the Pyrometer, a pint (0·568 litre, or 34·66 cubic inches) of water is measured into the copper vessel, and the sliding pyrometer scale *c* is set with its zero at the temperature of the water as indicated by the mercury thermometer *b*; a **Copper Cylinder** *d* is then put into the furnace or hot blast current the temperature of which it is wished to ascertain, and is allowed to become heated for a time varying from 2 to 10 minutes according to the intensity of the heat to be measured.

It is then to be withdrawn and quickly dropped into the water in the copper vessel, where it raises the temperature of the water in the proportion of 1° for each 50° of the temperature of the copper. The rise of the temperature may then be read off at once on the pyrometer scale, and if to this is added the temperature of the water as indicated on the mercury thermometer before the experiment, the exact temperature required is obtained.

For very high temperatures Platinum cylinders may be employed instead of Copper.

Price of Siemens' Water Pyrometer, with Thermomometer and six copper cylinders, complete £4 4 0

Water Pyrometer, with Thermometer and six wrought-iron cylinders, complete . £4 0 0

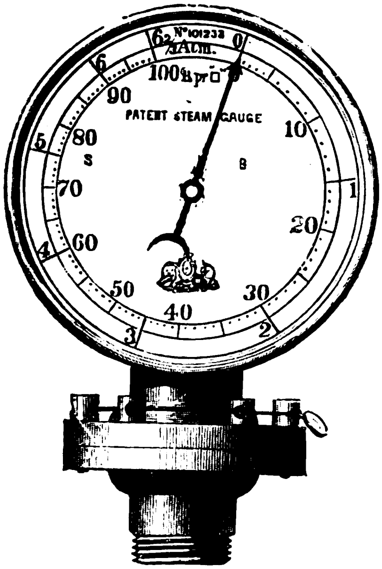


FIG. 525.

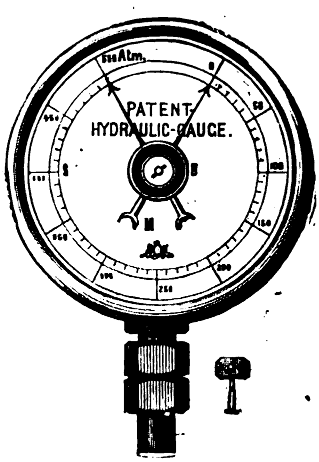


FIG. 531.

SCHÄFFER'S STEAM PRESSURE AND VACUUM GAUGES.

Gauges of any Pressure not exceeding 300 *lbs. per square inch,* 800 *feet of water, and Vacuum Gauges :—*

			£	s.	d.
524	**For Portable Engines,** Brass Case. 3-inch dial . .		1	8	0
	Ditto ditto	4-inch, with wire guard	1	15	0
525	**No. 1. In Metal Case,** with Brass Rim	6-inch dial	2	2	6
	No. 2. In Brass Case . . . (fig. 525)	"	2	10	0
526	**No. 3. In Metal Case,** with Brass Rim	7 "	2	7	6
	No. 4. In Brass Case	"	2	10	0
527	**No. 1. Patent Steel Tube Metal Case,** with Brass Rim, above 300 lbs. up to 1,000 lbs. . .	6-inch dial	2	15	0
528	**No. 2. Ditto Brass Case,** above 300 lbs. up to 1,000 lbs.	6 "	3	3	0
529	**12-Inch with Transparent Dial** for Dark Engine Rooms, Metal Case, with Brass Rim		3	3	0

530 **Combined Pressure and Vacuum Gauges,** at a slight increase of these prices.

531	**Hydraulic Gauge,** above 1,000 lbs. up to 10 tons, with Maximum Pointer and loose nuts for connecting (fig. 531)	10-inch Dial	5	5	0
	Ditto ditto	6-inch Dial	4	10	0
	Ditto ditto to 4 Tons		4	0	0

For each additional ton, 5s. extra. Maximum Finger applied to any gauge, 10s. extra.

532 **Dynamometer, Schäffer's.** The dial showing the weight is accurately divided, by applying dead weight. Two solid curved steel bars act as springs. Weight or strain applied has the tendency to straighten these springs, and the slightest motion of the same is multiplied and transferred by a suitable arrangement to a pointer which indicates the correct weight on the dial. Two strong rods outside the springs, moving loosely in their joints, act as safeguards in case the springs break.

Price, up to 20 tons . . £25 0 0

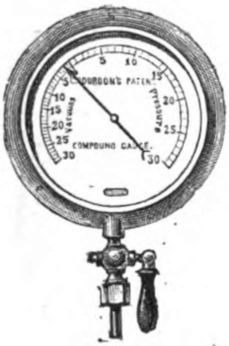


FIG. 4.

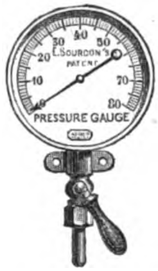


FIG. 5.

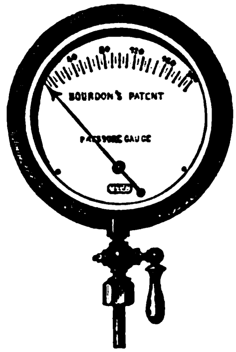


FIG. 2.

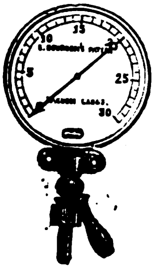


FIG. 7.

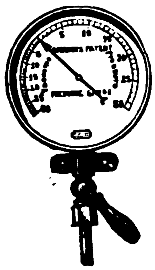


FIG. 8.

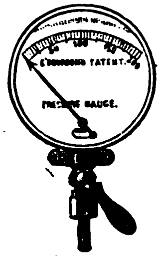


FIG. 6.

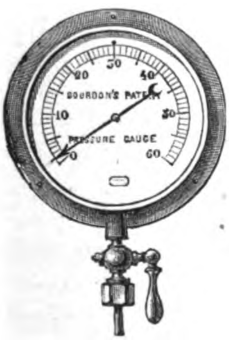


FIG. 1.

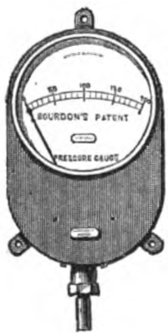


FIG. 9.

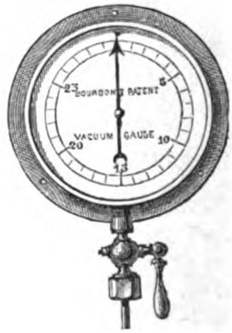


FIG. 3.

E. BOURDON'S STEAM PRESSURE AND VACUUM GAUGES.

PRICES FOR

E. BOURDON'S
OWN-MAKE STEAM AND VACUUM GAUGES.

TRADE **E. BOURDON** Invent^r & Manufac^r MARK.

Gauges not bearing above Trade Mark are not of Mr. Bourdon's Manufacture.

Diameter of Dial.	PRESSURE GAUGES. Number.	With Eccentric Hand. Figs. 2 and 6.	Number.	With Central Hand. Figs. 1 and 5.	Vacuum Gauges. Figs. 3 and 7.	Compound Gauges. Figs. 4 and 8.
		Each.		Each.	Each.	Each.
10 inches.	No. 0	£2 18 0	No. 0	£3 0 0	£3 2 0	£3 13 0
7 "	No. 3	1 16 0	No. 4	2 0 0	2 2 0	2 6 0
6 "	No. 5	1 14 0	No. 5c	1 18 0	1 18 0	2 4 0
5 "	No. 8	1 8 0	No. 8c	1 10 0	1 10 0	1 14 0
4 "	No. 7	1 5 0	No. 7c	1 7 0	1 7 0	1 12 0
3 "	No. 6	1 4 0	No. 6c	1 5 0	1 5 0	1 10 0
	Above Gauges in round cases of polished brass with or without flange, graduated to all pressures up to 300 lbs. per square inch, and fitted with gun-metal cocks and union complete. Gauges *above* 300 lbs. per square inch are *without* cocks.					
5 inches.	No. 2, fig. 9, Oblong Iron case (9 × 6 in.) with connecting screw joint, each, £1 6 0					

Above prices are for all pressures up to 300 lbs. per square inch. From 300 to 1,400 lbs. pressure per square inch there will be an additional charge of Two Shillings for every 100 lbs. above 300 lbs.

Cocks for 5 in., 7 in., and 10 in. Gauges, for pressure above 300 lbs. per square inch, up to 1,400 lbs. will be Twelve Shillings each.

NEGRETTI & ZAMBRA,

AGENTS, LONDON.

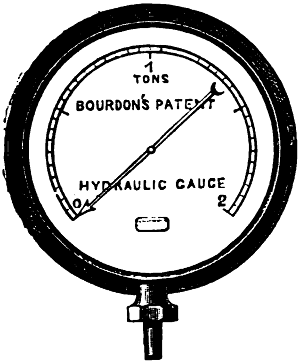


FIG. 14.

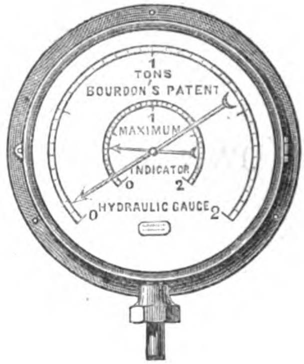
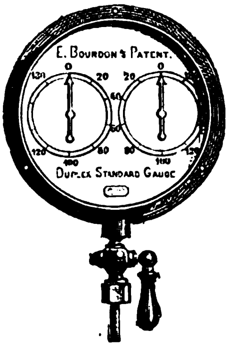


FIG. 10. FIG. 11.

E. BOURDON'S HYDRAULIC GAUGES.



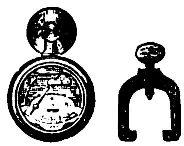


FIG. 12.

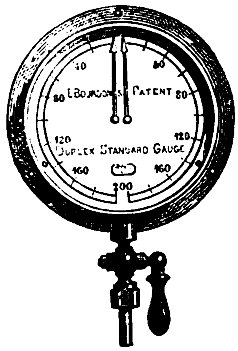
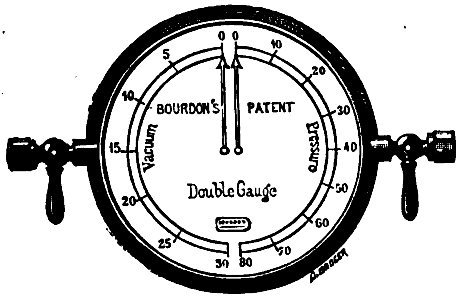


FIG. 16. FIG. 13. FIG. 15.

E. BOURDON'S STANDARD AND DUPLEX GAUGES.



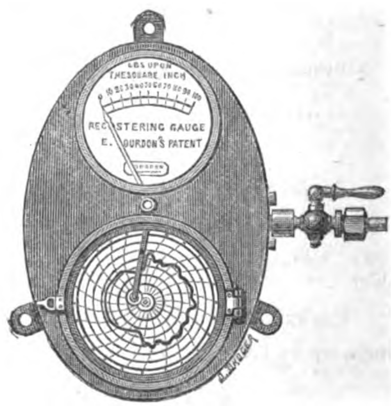


FIG. 18. FIG. 17

E. BOURDON'S DOUBLE AND REGISTERING GAUGES.

BOURDON'S HYDRAULIC GAUGES*.

With Central Hands, divided from 300 lbs. up to 5 tons per square inch.

Diameter of Dials.	With Connecting Screw Joint. Fig. 10.	With Maximum Pointer. Fig. 11.	With Valve, Union, and Maximum Pointer.	With Valve, Union, and Electrical Contact.
	Each.	Each.	Each.	Each.
10 inch.	£4 0 0	£4 10 0	£5 10 0	£6 0 0
7 "	3 5 0	3 10 0	4 8 0	5 0 0
5 "	2 10 0	2 16 0	3 8 0	4 0 0

Cocks for above Gauges (if required) 30s. each, extra.

BOURDON'S STANDARD AND DUPLEX GAUGES.

Used by Inspecting Engineers for Testing Gauges and Boilers.

	Diameter. 3 inches. £ s. d.	5 inches. £ s. d.
Fig. 12. **Pocket Standard Gauge,** with open face, in polished brass case, engraved dial, graduated to 300 lb. per square inch, in morocco case and clamp screw each	2 8 0	3 0 0
Fig. 13. **Two Gauges** as the preceding, but fixed on the same union and in a mahogany box . . . . per pair	6 3 0	7 13 0
Fig. 14. **Pocket Standard Duplex Gauge,** in polished brass case (5 inches diameter) engraved dial graduated to 300 lbs. per square inch, in morocco case and clamp screw . . . . each		6 5 0
	7 inches.	10 inches.
Fig. 15. **Standard Duplex Gauge,** with two concentric hands, polished brass case, graduated to 300 lbs. per square inch, with gun-metal cock . . . . . each	3 16 0	5 0 0
Fig. 16. **Standard Duplex Gauge,** with independent hands, &c., as last	3 14 0	4 15 0

EXTRA CHARGES.

Diameter of Gauge.	Maximum or Minimum Pointer.	Second Scale of Feet of Water or Atmospheres.	For 3-way Cock.	Writing Name on Dial.	Open Face.
	Each. s. d.	Each. s. d.	Each. s. d.	Each. s. d.	Each. s. d.
10 inch.	10 0	5 0	2 0	1 0	10 0
7 "	7 0	5 0	2 0	1 0	10 0
6 "	7 0	5 0	2 0	1 0	8 0
5 "	5 0	3 0	2 0	1 0	8 0
4 "	5 0	3 0	2 0	1 0	8 0
3 "	5 0	3 0	2 0	1 0	8 0

Fig. 17. **Bourdon's Registering Gauge,** in japanned case, graduated to 100 lbs. per square inch, with gun-metal cock and union, and 100 printed cards £7 15 0
Extra cards (if required) per 100 . . . . 0 8 0

Fig. 18. **Bourdon's Double Gauge,** to be set in Engine-rooms, and showing on the same dial (10 inches diameter) pressure of Steam in the Boiler, and the amount of Vacuum in the Condenser, Polished brass case, and two cocks with union £6 0 0

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* A Table of Hydraulic Pressure will be found in the Appendix.

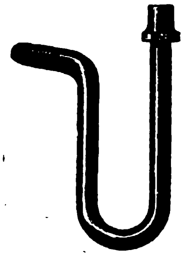


FIG. 24.

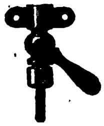


FIG. 20.


FIG. 21.


FIG. 19.

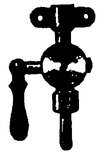


FIG. 23.

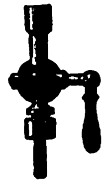


FIG. 22.

FITTINGS AND CONNECTIONS FOR BOURDON'S GAUGES.

			£	s.	d.
Fig. 19.	Connecting Screw Joint	each	0	1	6
Figs. 20 & 21.	Gun-Metal Cock.	„	0	4	0
Figs. 22 & 23.	Three-way Cock for Standard Test Gauges . .	„	0	6	0
Fig. 24.	Iron Syphon, with Union	„	0	4	0
Fig. 24.	Copper Syphon, with Union	„	0	4	6

Purchasers are desired to examine and compare M. Bourdon's Gauges. They will find the works to be constructed and finished like a watch, whilst the majority of imitations are put together ROUGH FROM THE CASTINGS, consequently liable to adhere and give erroneous indications.

Steam Hydraulic Pressure and Vacuum Gauges tested, corrected, and repaired by Negretti and Zambra.

GUN-METAL FITTINGS FOR MARINE, LOCOMOTIVE, AND OTHER STEAM ENGINES AND BOILERS.

Gun-metal Steam and Water Taps of all sizes and shapes, Safety Valves, Steam Whistles, Gauge Taps High Pressure, Water and Steam Valves, Gas Valves, Boiler Fittings of all kinds, Feed Pumps and Valves, Wrought Iron Steam, Gas, and Water Tubes, Boiler Tubes, Hand Force Pumps, Fire Engine and Brewery fittings, Pump fittings, Caps and Screws of every form, Hydraulic Presses and Force Pumps, Hydraulic Rams of various sizes and construction, Turning Lathes and Tools, Portable Forges and Smiths' Tools, &c., &c., Railway Metal, Tools and appliances of all kinds supplied to order by Negretti and Zambra, of the very best manufacture.

At pages 73 and 97, will be found Anemometers for testing Ventilating or Furnace Shafts and Wind Pressure, Recording Anemometers, and Tide Gauges, &c.

Foreign Correspondents sending particulars of their requirements to Negretti and Zambra may rely upon the personal attention of the Firm in carrying out commissions entrusted to them in this special branch of their Shipping Business.

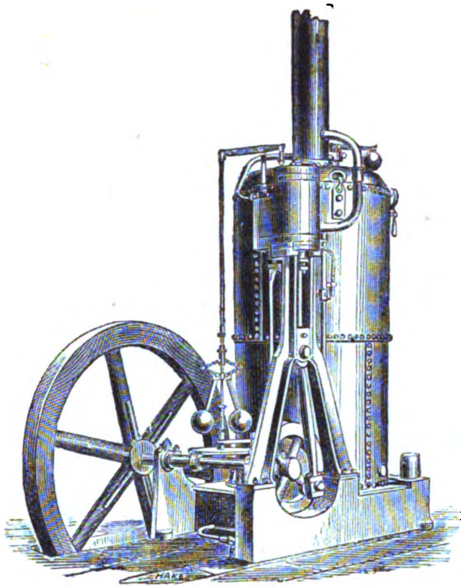


FIG. 583.

533 **Improved Combined Portable Steam Engine and Boiler.** These Engines are fitted with governor, throttle valve, safety valve, feed pump, water and steam gauge, &c., &c., *complete, ready for immediate use.* Recommended for simplicity and economy; well suited for Exportation.

Consumption of fuel, $7\frac{1}{2}$ lbs. of coal } per horse power,
Ditto ditto water, 1 cubic foot } per hour.

*Horse Power	Cylinder. Diameter.	Stroke.	Boiler. Height.	Diameter.			
2 ,,	4-in.	10-in.	,, 5-ft. 0-in.	2-ft. 4-in.	£73	0	0*
3 ,,	$4\frac{3}{4}$-in.	10-in.	,, 5-ft. 6-in.	2-ft. 4-in.	85	0	0*
4 ,,	$5\frac{1}{2}$-in.	12-in.	,, 7-ft. 0-in.	2-ft. 4-in.	105	0	0
6 ,,	$6\frac{1}{2}$-in.	14-in.	,, 8-ft. 0-in.	2-ft. 8-in.	165	0	0

* 2 and 3, if not fitted with Governors, less £5.

The fly-wheel shaft is made sufficiently long to admit of a drum being fixed on if required, which can be supplied (to any diameter ordered) along with the Engine, at an extra cost according to size.

The above Engines occupy a very small space, and will be found admissible in places were no other form of engine and boiler could be fixed. They are constructed in an exceedingly substantial and simple manner, every part being perfectly easy of access, and consequently can be readily understood and managed.

The boilers are fitted up with strong welded tubes (varying in number according to the size of the boiler), intersecting the fire-box, and a mud hole is placed opposite each tube, for the purpose of cleaning them out. They are tested up to 200 lbs. pressure to the square inch.

The foundation plate answers the purpose of feed water tank, in which the water is heated before passing into the boiler; and also of an ashpit.

No brickwork or foundation is required.

N. and Z. will forward special quotations to Foreign Correspondents for Steam and other Machinery upon receiving details of the nature and amount of work to be performed.

SURVEYING INSTRUMENTS, THEODOLITES, LEVELS, CIRCUMFERENTERS, COMPASSES, ETC.

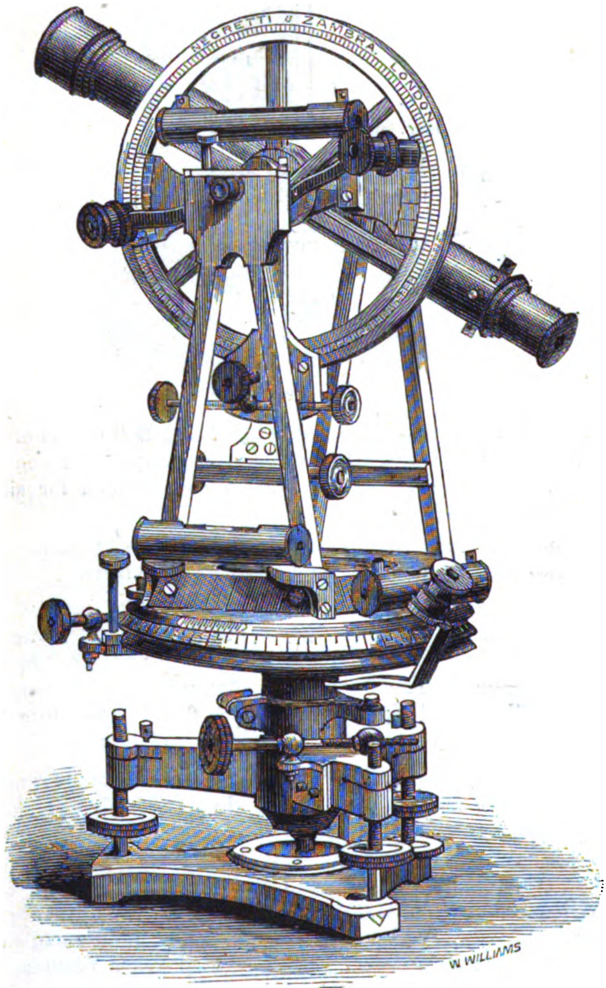


FIG. 55C.

The construction and accuracy of the instruments enumerated in this section being of the first importance, Messrs. NEGRETTI AND ZAMBRA devote special attention to this particular branch of manufacture, to insure the most perfect finish and precision that can be obtained by modern improvements in machinery, dividing engines, &c.

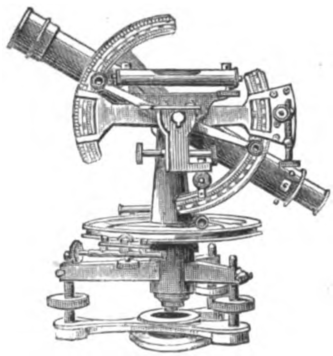


FIG. 545.

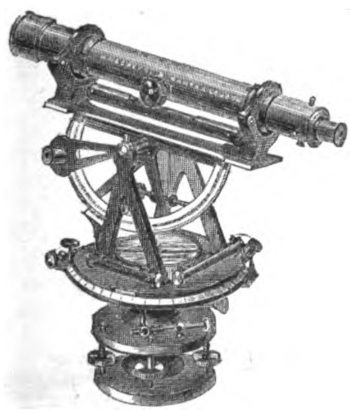


FIG. 536.

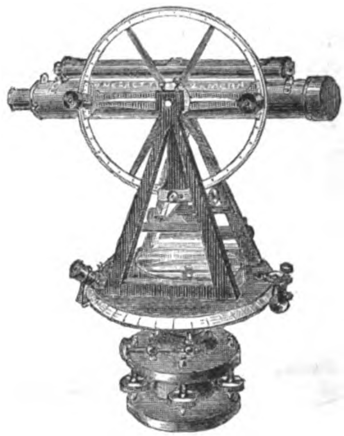


FIG. 540.

THEODOLITES.

		Each. £ s. d.
534	**4-inch plain Military Theodolite,** with Telescope and staff complete, divided on **Brass**	13 13 0
535	**4-inch Theodolite, divided on Silver,** with three tangent screws, tripod staff, &c., complete	21 0 0
536	**5-inch Best Theodolite, divided on Silver,** to 30 seconds, with three tangent screws, rackwork adjustment to telescope, tripod staff, complete; with stout mahogany box and improved screwed packings, strong brass handle and loops adapted for a strap (fig. 536) . .	24 0 0
537	**6-inch Best Theodolite, divided on Silver,** to 20 seconds	31 10 0
538	**7-inch ditto ditto**	35 10 0
539	**6-inch Best Theodolite,** divided on Silver, with **two Telescopes**	38 10 0
540	**Transit Theodolite,** 5-inch best, *divided on Silver,* reading to 30 seconds (fig. 540). The tangent and clamping adjustments are of the most approved construction	29 0 0
541	**Ditto ditto** 5-inch, with axis level, *divided on Silver,* reading to 30 seconds	33 0 0

No.	Description	Each. £ s. d.
542	**Transit Theodolite,** 6-inch with ditto, reading to 20 seconds ..	36 0 0
543	**Ditto** ditto, 6-inch with ditto and lantern, reading to 10 seconds	42
544	**Ditto** ditt', 8-inch with ditto . . . . , . . .	55 10
545	**Everest's Theodolites,** 4-inch, **divided on Silver** to 30 seconds, with triangular locking plate (fig. 545)	22 0 0
546	**Ditto ditto,** 5-inch, ditto 20 seconds	26 10 0
547	**Ditto ditto,** 6-inch, reading to 20 seconds	33 0 0
548	**Ditto ditto,** 7-inch, reading to 10 seconds	37 0 0
549	**Ditto ditto,** 10-inch, reading to 10 seconds, with open braced stand, lantern, and axis level	63 0 0

550 **Azimuth and Altitude Instrument, or Transit Theodolite,** 7-inch, as fig. 550. The vertical and horizontal circles are divided on Silver, improved magnifying readers to the divided circles, inverting an erect eyepieces, tangent screw adjustment levels, locking plates, with Tripod stand and polished Mahogany cabinet for the instrument with lock and key 46 0 0

550° **Azimuth and Altitude Instrument,** 8-inch illuminated axis, with lamp, &c., complete as above 56 0 0

Diagonal eyepieces for either of above, 30s. extra.

For description and prices of larger Transit instruments, &c., &c. See Section Astronomical Instruments.

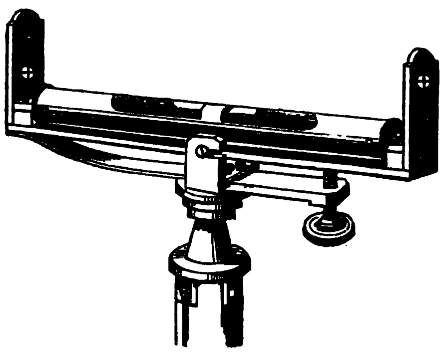


FIG. 556.

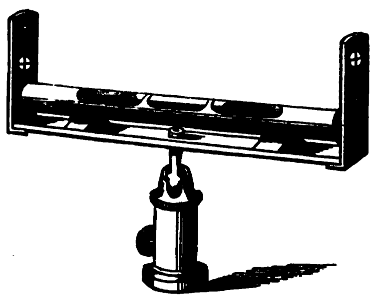


FIG. 552.

DRAINAGE AND SURVEYING LEVELS.

551 **4-inch Pocket Spirit Level, or Clinometer,** brass frame, with sights and graduated arc for determining the inclination of strata, &c., with socket for staff; in mahogany box 3 10 0

552 **Drainage Level,** of brass, with plain sights, and ball-and-socket joint (fig. 552) £1 10 0 2 10 0

553 **Improved Draining Level,** with sights and spring adjustment, mounted on brass head and mahogany tripod stand . . . 3 3 0

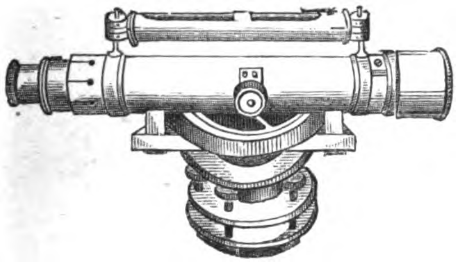


FIG. 558.

FIG. 557.

		Each. £ s. d.	Each. £ s. d.
554	**Improved Draining Level,** folding sights, and superior finish		4 4 0
555	Ditto ditto, with adjustment to the sights, ball-and-socket joint		3 3 0
556	**Drainage Level, Ordnance Pattern;** brass mounted, with plain sights, spring adjustments to level, brass jointed tripod stand, in mahogany box (fig. 556) . .		5 5 0
557	**8-inch Drainage Level,** with rackwork adjusting telescope, parallel plates, in mahogany case and tripod stand (fig. 557)		6 6 0
558	**8-inch Drainage Level,** with rackwork adjusting telescope, compass, parallel plates, in mahogany case and tripod stand (fig. 558)	7 7 0	8 8 0

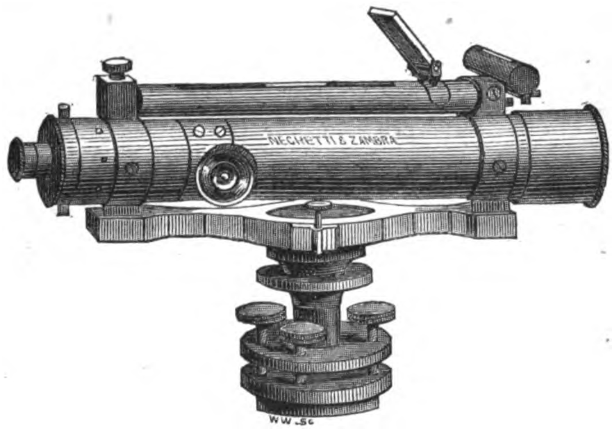


FIG. 560.

559	**10-inch best Dumpy or Gravatt's Level,** with achromatic telescope and rackwork adjustment, divided bubble tube, Silver ring compass, mirror and cross bubble, strong brass parallel plates, with stout mahogany tripod staff, and case with brass loops for a strap	13 13 0

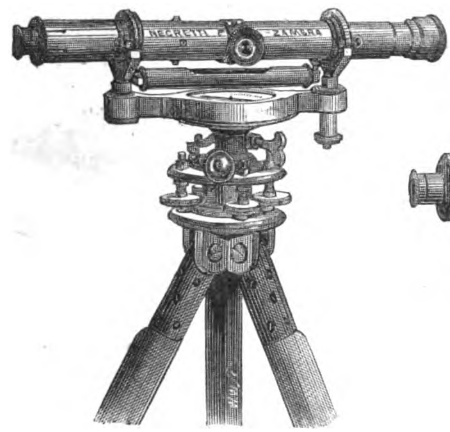


FIG. 563.

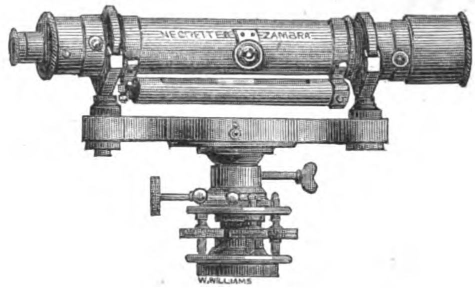


FIG. 566.

		Each. £ s. d.	Each. £ s. d.
560	**12-inch Best Dumpy or Gravatt's Level** (fig. 560) . .		14 14 0
561	**14-inch ditto** ditto		16 16 0
562	**18-inch ditto** ditto		18 18 0
563	**Best Y Level,** with 12-inch Achromatic Telescope and rackwork adjustment, compass, tangent screw adjustment, parallel plates, and stout tripod staff; in case, &c. (fig. 563).		17 17 0
564	Ditto ditto, with 18-inch Telescope		18 18 0
565	Ditto ditto, with 24-inch Telescope		22 0 0
566	**Negretti and Zambra's Improved Ordnance Pattern 15-inch Level, or Dumpy Y Level** (fig. 566), with reversing and adjusting Y's to Telescope, divided bubble tube, Silver ring, compass, tangent screw and clamp on limb, parallel plates, and stout mahogany tripod stand, and case with brass loops and strap . . .		18 18 0
567	**Standard Levelling Instrument,** as constructed for the Government Survey		42 0 0

Theodolites and Levels mounted with the improved Locking Plates, as figs. 545 and 550 at about 50s., 60s., and 70s., extra charge, according to the size of the instrument.

HAND LEVELS, FOR BUILDERS, ENGINEERS, ETC.

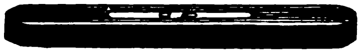
568 **Spirit Levels,** mounted in polished mahogany frames, with brass top (fig. 568):—

Length—inches .	4.	5.	6.	7.	8.	9.	10.	12.
Price . . .	2s. 6d.	3s.	3s. 6d.	4s.	4s. 6d.	5s.	5s. 6d.	6s.

569 Ditto ditto **Brass-tipped at bottom.** Superior finish.

Length—inches	6.	8.	10.	12.
Price	4s. 6d.	5s. 6d.	6s. 6d.	7s. 6d.
570 Ditto ditto **Brass-plated at Bottom**	5s. 6d.	6s. 6d.	8s. 6d.	10s. 6d.

FIG. 568.



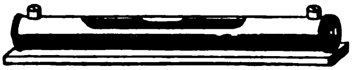


FIG. 573.

FIG. 572.

571 **Spirit Levels,** rosewood frames, and German silver mountings:—

Length—inches	6.	8.	10.	12.	18.
Price	6s. 6d.	7s. 6d.	10s. 6d.	12s. 6d.	16s. 6d.

572 **Spirit Levels,** plain Brass mountings (fig. 572):—

Length—inches	4.	6.	8.	10.	12.
Price	5s.	6s.	10s.	12s.	13s. 6d.

573 **Spirit Levels,** Brass mountings, with adjusting screws and **best ground tubes** (fig. 573):—

Length—inches	4.	6.	8.	10.	12.
Price	10s. 6d.	12s. 6d.	16s. 6d.	22s.	32s.

If with divided tubes, extra.

No.	Article	Each. £ s. d.	Each. £ s. d.
574	**Circular Pocket Spirit Level** (fig. 574)		0 6 6
575	**Spirit Level Tubes,** plain, marked and warranted, per inch		0 0 3
576	Ditto ditto ditto best ground . . . „	0 0 4	0 0 6
577	Ditto ditto ditto best ground and graduated „		0 0 6
578	**American Universal Hand Level,** for levelling floors, ceilings, or walls		0 16 0

CIRCUMFERENTERS, OR MINER'S DIALS, CROSS SIGHTS, ETC.

No.	Article	£ s. d.
579	**Circumferenter,** or Miner's Dial, 4-inch **Ordnance pattern** divided and figured on raised rim to 360°, and also the quarters figured below to 90°, folding sights, ball and socket joint with clamping screws, edge bar n eedle and agate centre with lifter the dial lettered the same as a theodolite, jointed mahogany legs and cases for compass and stand	7 7 0
579*	**Circumferenter,** 5-Inch ditto ditto with **Cross Levels**	8 8 0
580	**Circumferenter,** 5-inch, with rackwork adjustment and vernier to dial, bar needle and agate centre and lifter, folding sights, ball and socket joint, divided cover for vertical angles, jointed legs, complete with plummet, &c., in two cases	9 9 0

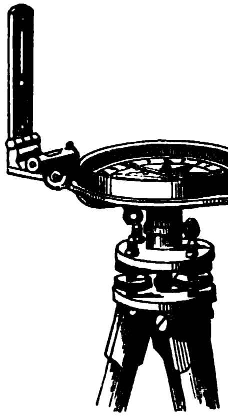


FIG. 581.

FIG. 574

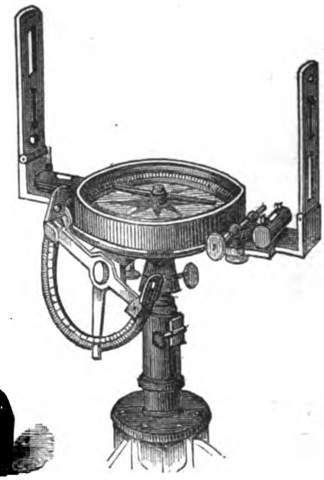


FIG. 582.

Each. £ s. d.

581 **Best Circumferenter,** 6-inch, with rack-work adjustment and vernier to dial, bar needle with agate centre, folding sights, divided cover for hypo and base, cross levels, with tripod staff, jointed, extra points for use at half-length, and ball-and-socket joint with plummet, &c., &c., in two cases complete (fig. 581) . 12 12 0 15 15 0

582 **Circumferenter,** 6-inch, or **Hedley's** inclining dial, improved form folding sights, two spirit levels, bar needle with agate centre, rack adjustment to dial, two verniers reading to three minutes of a degree, tangent screw adjustment, divided arc for hypo and base, with plain sights, complete with ball and socket stand, joint legs for use at half-length, extra points, plummet, &c., &c., in case complete (fig. 582) 15 15 0 17 17 0

582° **Circumferenter, Hedley's Improved,** with Telescope, interchangeable Sights and Levels, Tangent Screw and Clamp adjustments, Parallel Plates instead of Ball and Socket Joint, &c., &c.; being the most complete form of Miner's Dial 25 0 0

583 **Circumferenter, Lean's,** 6-inch improved, with **Telescope,** for surface surveying, centre quadrant, with level attached, shifting sights; vernier reading to two minutes, best bar needle, cross levels, rack-work adjustments, Arc divided on one side 90° each way and on reverse for hypo and base, jointed tripod stand, with extra points, &c., in case complete 19 10

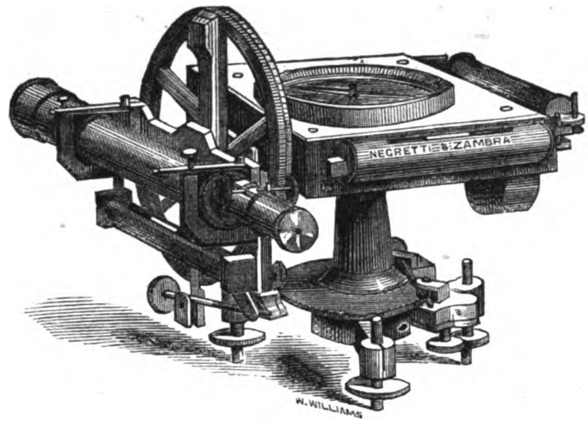


FIG. 584.

584 **Under-ground Theodolite** (French Model) for Mining, General Surveying, Levelling, or Military Service (fig. 584).

Combining in one instrument and a very compact form, the conveniences of a Y or Dumpy Level, Circumferenter, and to a certain extent a Theodolite. On the top of the vertical axis of the instrument is a compass with divided ring reading by verniers, as in the best forms of Circumferenter. On two sides of this compass are placed Spirit Levels with the usual adjustments for azimuth observations. Attached to the limb of the instrument is a vertical divided circle, upon which is a Telescope mounted in reversing and adjusting Ys. A spirit level with adjusting screws is placed upon the body of the Telescope similar to that of a Theodolite.

Vertical angles are obtained and read off on the vertical divided circle by two arms and a vernier scale attached to the axis of the Telescope mounting.

The Telescope has cross wires in the Eye Tube, which is moved by a fine rack-work adjustment. Clamps and tangent screws are attached to both the horizontal and vertical movements, by which they can be adjusted to a very great exactness. With Tripod stand and mahogany box for the instrument. *Price* . £22 0 0

Plain Sights to fit on the Compass box or on the Telescope, Astronomical and Diagonal Eye Pieces, Dark Glass Caps for Sun observations,—supplied *to order* at an extra cost.

		Each. £ s. d.	Each. £ s. d.
585	**Miner's Compass**, 4-inch, with folding sights, in mahogany case	1 10 0	2 10 0
586	Ditto ditto, with Spirit Levels, &c., mahogany box (fig. 586)	2 10 0	3 0 0
587	**Pocket Mining Compass**, plain, with Sights, round brass box, bar, needle, and stop (fig. 587)		0 16 0
588	Ditto ditto, in round gilt cases, with bar, needle, and stop (fig. 588) . . . . 15s.	0 18 0	1 5 0

See also Pocket Compasses.

Graphometres. Under this name a number of rough surveying instruments are manufactured in Paris and various cities on the Continent. They are either semi-circles or complete circles divided into 360 degrees, fitted with two or four sights, either folding or fixed, revolving upon the divided circle reading by verniers. In some a Compass is added for azimuth observations. Still more complete instruments have one or two Telescopes, with various adjustments, making them very similar to the ordinary arrangements of English Miner's Dials, and an improved form of the old Plain Table.

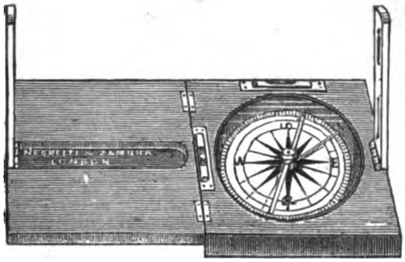


FIG. 586.

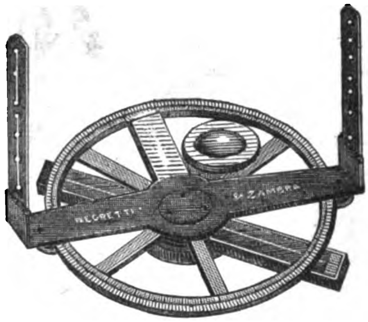


FIG. 589.

No.		Each. £ s. d.	Each. £ s. d.
589	**Graphometres or plain Surveyor's Dial,** 7½-inch divided circles, folding sights, level and bar needle and circular spirit compass, ball-and-socket tripod stand, &c. The instrument fitted into a mahogany box (fig. 539) *Price*		16 16 0

Our engraving (fig. 589) exhibits an instrument of this class manufactured by Messrs. Negretti and Zambra for Colonial service, where a simple, strong, portable, but inexpensive and accurate instrument is required for preliminary survey. It has a firm tripod stand fitted with a ball-and-socket joint, so that either horizontal or vertical angles can be ascertained very expeditiously.

FIG. 590.

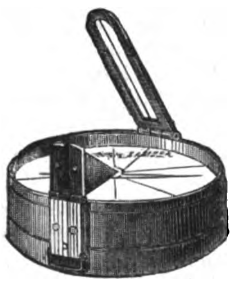


FIG. 595.

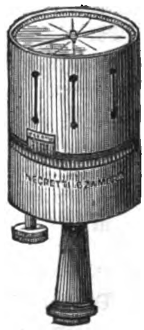


FIG. 592.

590	**Surveyor's Cross,** octagonal form (fig. 590)	0 10 6	0 12 6
591	Ditto ditto, with **Compass**		1 5 0
592	Ditto ditto (or Pantométre), with **moveable** head and divided circle and compass (fig. 592) of the best construction		2 10 0
593	Ditto ditto, with **Tripod Stand,** with ball-and-socket joint		4 15 0
594	**Optical Squares,** for showing right angles	1 1 0	1 10 0
594*	**Ditto** ditto with adjustment in case		2 0 0

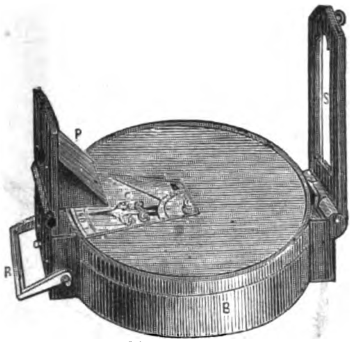


FIG. 603.

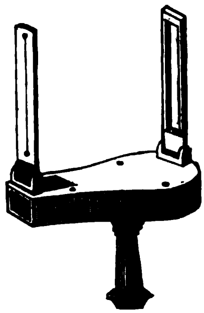


FIG. 606

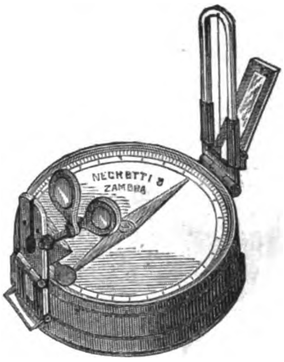


FIG. 599.

PRISMATIC MILITARY SURVEYING COMPASSES.

No.		Each. £ s. d.	Each. £ s. d.
595	**Prismatic Compass (Kater's),** plain sights and card dial (fig. 595) 2-inch, 30s. 2½-inch, 42s. 3-inch,		2 10 0
596	**Prismatic Compass, 3-inch,** diameter, with shades and mirror, card dial		3 3 0
597	Ditto ditto with engine divided Silver or Aluminium ring		3 10 0
598	Ditto ditto, best, **4-inch** with sun shades, card dial . .		4 4 0
599	Ditto ditto, best engine divided Silver or Aluminium ring, with Sun-shades and Azimuth Glass (fig. 599) . .		5 5 0
600	Leather case and strap for Prismatic Compass . .		0 10 6
601	**Stand for Prismatic Compass,** best mounted, **Ordnance Pattern,** with ball-and-socket joint		1 16 0
602	Ditto ditto, plain horizontal movement		1 8 0
603	**Hutchinson's Prismatic Compass** (fig. 603) 3-inch plain	2 0 0	2 10 0

604 **Combined Prismatic Compass and Pendulum Clinometer** in round brass box similar to the ordinary Prismatic Compass. By the Compass *horizontal* angles may be ascertained in the ordinary way, and by the Pendulum or weighted wheel *vertical* angles can be very conveniently observed. This is a simple and handy little pocket instrument for rapid surveys, Geologists' use, &c., &c. Both horizontal and vertical angles are read off by the prism and hair-line sight upon the divided card or metal circle.

No.		Each. £ s. d.	Each. £ s. d.
605	**Pendulum Wheel Prismatic Clinometer,** with Card Dial Compass		4 4 0
	Ditto ditto, *large size* with divided Silver ring compass sunshades and azimuth mirror		5 5 0
606	**Captain Burnier's Military Prismatic Compass** for measuring vertical and horizontal angles (fig. 606) .	5 5 0	6 6 0
	This instrument is very similar in construction and use to the Pocket Alt-Azimuth described page 202		
607	**Tripod stand** for ditto with ball-and-socket movement for either of above		1 16 0

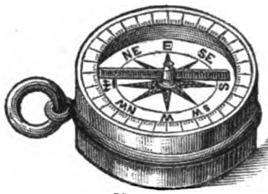
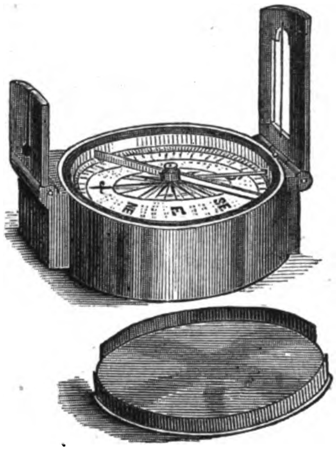


FIG. 588.

FIG. 608.



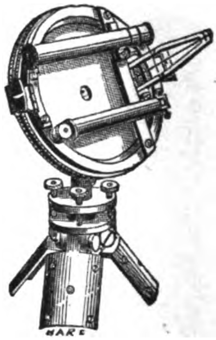


FIG. 608*.

FIG. 587.

608 **Improved Telescopic Prismatic Compass.** By it both vertical and horizontal angles can be taken with speed and accuracy. Inside the compass box is a silver ring, divided to 30°; this gives the magnetic bearing, even when the instrument is held in the hand. On the tripod stand (as fig. 608), with the spirit level and telescope, horizontal angles can be taken independent of the magnetic needle; this is of great importance in districts abounding with iron. To measure vertical angles, the compass is used sideways (as in fig. 608*); the level then shows the horizontal line, and all angles can be taken from the zenith round. All observations can be verified by reversing the compass in azimuth and altitude . . . £12 12 0

609 **Standard Mountain or Surveying Barometer** (fig. 609), on Fortin's principle is more portable, and less liable to derangement than ordinary Mountain Barometers. The arrangement of the flexible leather cistern is so simple, that should the mercury become oxidized, it can be quickly removed, cleaned, and returned to the cistern without fear of affecting the correctness of the indications. The vernier reads to ·002 of an inch, and the whole instrument is arranged in a compact and convenient form for safety in travelling, and obtaining the most accurate Altitude measurements.

Price, including Tripod Stand (as fig. 609 or 609*) and stout Leather Travelling Case for the Barometer, &c. £10 10 0

See also page 11.

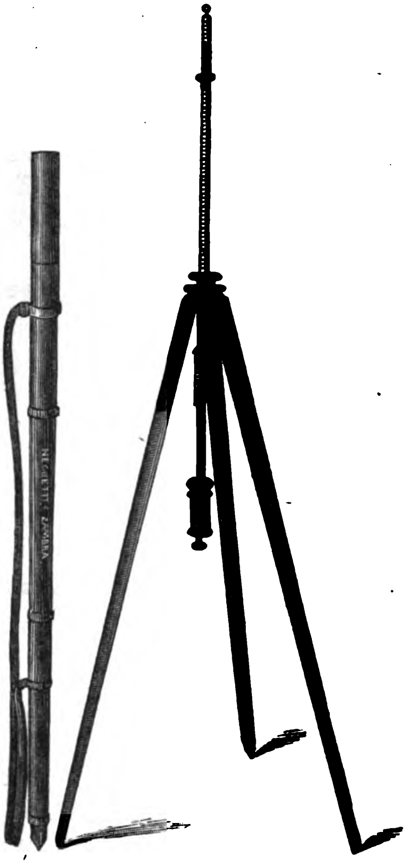


FIG. 609.

FIG. 609*.

ANEROID BAROMETERS FOR MEASURING ALTITUDES OR SURVEYING.

610 Owing to the inconvenient size of Mercurial Standard Barometers, and also from the great risk of breakage in transit, it often occurs that their use has been abandoned by surveyors where otherwise they would have been invaluable for strict altitude measurements.

This difficulty is almost entirely overcome by the use of Negretti and Zambra's Altitude and Surveying Aneroid Barometers. These instruments are now constructed with such precision that very small elevations may be ascertained with great exactness. The scale of the altitude aneroid is laid off by actual experiment in a vacuum chamber, the readings being noted both backwards and forwards, such readings being repeated at long intervals, and the observed differences corrected, before finally dividing the scale on the dile. Severe tests are also applied to the instrument in order to compensate for errors arising from varying extremes of temperatures.

Where it can be conveniently carried, Negretti and Zambra would in all cases recommend their full-sized Altitude Aneroid (fig. 611) for observers' use; as from the large diameter of the divided circle, exceedingly minute movements of the index hand may be seen with ease.

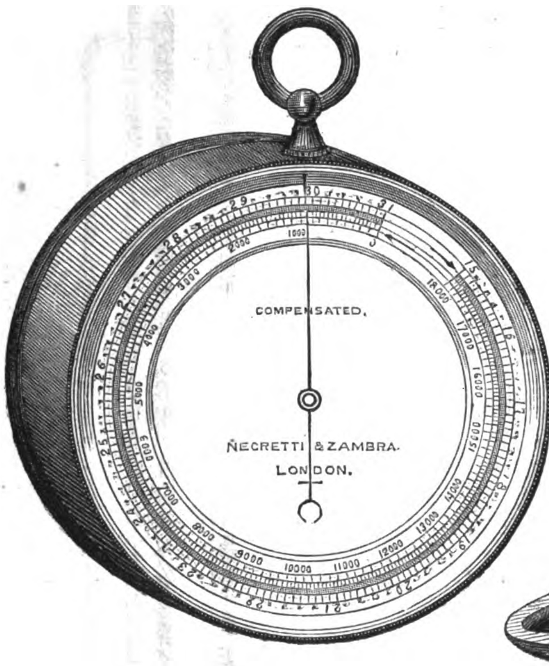


FIG. 611.

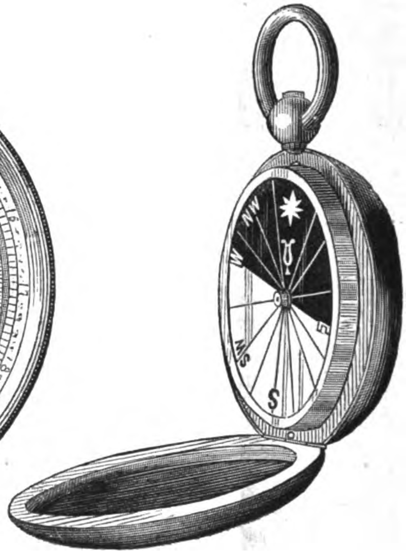


FIG. 617*.

Should it be that the large Aneroid cannot be carried, Negretti and Zambra can with confidence advise the use of their **Watch-sized Aneroids** with altitude scales. The *exact* size of these instruments is shown at page 19. A large number of such small Aneroids having been made by Messrs. N. and Z., and reports received of their wonderfully accurate performance in all parts of the world, warrant N. and Z. in giving the strongest recommendation to them. At page 22 will be found instructions for measuring heights by the Aneroid, and comparative tables of the English and French scales.

A copy of Professor Airy's Altitude Tables supplied with each instrument.

		Each. £	s.	d.
611	**Negretti and Zambra's full range Altitude and Surveying Aneroid Barometer** (Orometer), Compensated for temperature, the Scale divided to Inches and Hundredths or Millimetres, with Altitude Scale to 20,000 feet, or about 15 inches of the barometer scale (fig. 611) in hinged leather case	8	8	0
612	Solid leather case with Sling strap for Ditto	0	12	6
613	**Pocket Aneroid Barometer,** with Altitude Scales to 5,000 feet, moderate elevations; see *ante*, page 18 (fig. 20)	5	5	0
614	**Watch-sized Pocket Aneroid Barometers,** Compensated with Altitude scale to 10,000 feet; see *ante*, page 19 (fig. 22)	5	5	0
615	Ditto ditto, to 20,000 feet	6	6	0
616	Ditto ditto, to do **Silver case**	7	7	0
	Aneroid Barometers *with adjusting altitude scales* 10s. each extra.			
617	**Anemometer, Pocket, Biram's,** for registering the velocity of currents of air in mines, air shafts, drains, &c., &c. For full description and instructions for use, see pages 76 to 80.			
	4-inch size, £2 10s.; 2½-inch	2	2	0
617*	**Surveyor's Pocket Compasses,** with Bar Needle or Singer's Card Dial, in Silver Watch Case (fig. 617*) . . . . . £2 10s.	3	3	0

FIG. 619.

618 **The Dipleidescope.** A new Pocket instrument for obtaining the **Correct Time** with great facility, by observing the Transit of the Sun across the Meridian . . . . best form 10 10 0

619 **Perambulator,** for measuring the length of roads, streets, &c., consists of an accurately framed Wheel, the circumference of which is carefully ascertained; the axis of this Wheel is connected by a series of toothed wheels and pinions to a dial, upon which the number of revolutions of the Wheel are recorded. The divisions upon the dial are English measures; but any Foreign scale can be substituted to order. Price, with Brass mounted and strongly clamped wheel (fig. 619) . . . . £14 14s. £16 16s.

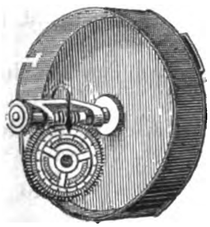


FIG. 622.

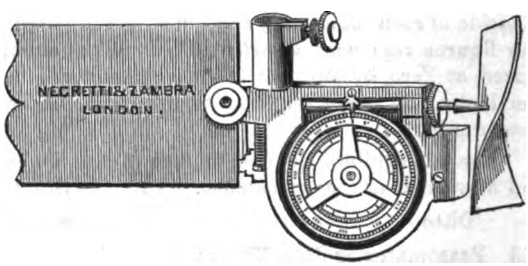


FIG. 623.

620 **Trocheameter,** for registering the revolutions of a carriage wheel and by this ascertaining distances travelled; it is also applicable for counting the revolutions of fly wheels, paddle wheels, &c., up to 10,000 revolutions, or nearly 23 miles distance, travelled by a coach wheel of 12 feet circumference. These numbers can be repeated by re-setting the instrument, which is very easily done, by removing a nut, and turning back the divided wheels to the 0 point. The Trocheameter is contained in a strong japanned metal case, 4 inches by 2 inches deep, fitted with a leather strap for attaching it to the wheel, &c. (fig. 622) £3 3 0

FIG. 620.

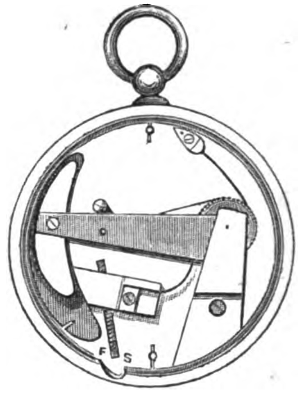


FIG. 620*.

621 **Pedometer** or Watch for Recording and Measuring the distance travelled by a Pedestrian.

This little instrument is generally carried in the waistcoat pocket or in the fob, or else attached to a belt or to a button; the hook attached to the ring must be so fastened to the slit of the pocket or elsewhere that the instrument be always in a *Vertical Position.*

It never requires any winding up, the first step of the Pedestrian sets the works in motion; they continue to act as long as he moves, and stop when he stops. The dial is divided into twelve divisions, which represent so many Miles, but can be adapted to record Kilometres or any other measure of distance by means of a governing screw, which is square-headed, so as to be turned by a watch key; all that is necessary to do is to walk a mile, and then observe the position of the index hand upon the dial; the regulator is then turned to the left for *Slow*, or to the right for *Fast*, until one division on the dial represents exactly the measure of distance chosen, Mile or Kilometre, &c. This of course will depend upon the length of stride of each individual, and must be regulated accordingly. The dots between the figures represent *Quarter Miles.* When about to start, the Index should be placed at Zero, by turning it either backwards or forwards with the finger. If the Pedometer is not required to act, it should be carried with the Pendant ring downwards.

Fig. 620 exhibits the dial or face of the Pedometer and fig. 620* the interior and movement of the instrument. *Price*, in Stout Silver Case . . £3 3 0

Ditto ditto *Price*, in Nickel Plated Case . . 2 10 0

622 **Passometer or Step Measurer**, is a similar sized instrument to the Pedometer, arranged to record the number of paces or steps taken by the wearer. These are indicated on the face of the instrument by a small circle (similar to the seconds dial of an ordinary watch) up to 50, and then on the large dial by a series of divisions, each equally 50 paces up 2·500, the readings on the dial are continuous as in the Pedometer. *Price*, in Stout Silver Case . . £5 5 0

622° **Chronograph.** Without stopping the movement of the watch the long seconds' hand of this instrument records on the Dial the interval between two given events, with unfailing accuracy. *Price*, in Gold Case, 60 guineas; Silver Case, 45 guineas; or to go for two hours only, Gold, £20; Silver, £12 12s.

No.	Description	Each. £ s. d.	Each. £ s. d.
623	**Current Metre,** for ascertaining the tidal rate or flow of streams or rivers, in Miles, Furlongs, and Feet; the amount of Water delivered per hour in Cubic Gallons and inches; and the Dynamic force of the current. This instrument can also be used as a Log, to determine the rate of a ship's speed. The scales on the divided wheels are laid off by careful experiment (fig. 623). Price, in mahogany box	£6 6 0	7 7 0
624	**Hydroscope or Telemeter,** a simple apparatus constructed by Negretti and Zambra for the government Ordnance Department for use in Marine Forts to estimate the distance of vessels and other objects		5 0 0
625	**Clinometer or Inclinometer,** 12-inch, plain boxwood, with divided semi-circle and plumb, for ascertaining the inclination of roads, drains, strata, &c., in a rough way. The divisions on the arc show degrees and inches per yard; it has also an inclination scale. Price, in pull-off case		0 16 6
626	**Clinometer,** 12-inch boxwood, brass jointed, with divided arc and inclination scale, forming a pocket rule		1 1 0

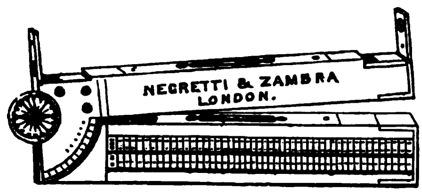


FIG. 630.

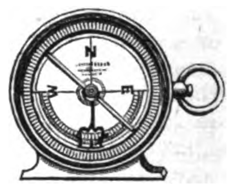


FIG. 634.

No.	Description	Each. £ s. d.	Each. £ s. d.
627	**Clinometer,** 6-inch, plain jointed, without sights or Compass		1 1 0
628	**Clinometer,** 6-inch, with spirit level, magnetic Compass, and inclination scale	1 18 0	2 2 0
629	Ditto ditto, bar needle Compass, and two levels . .		2 10 0
630	Ditto ditto, with best bar needle and agate centre Compass in the joint (fig. 630)		3 3 0

The inclination scale placed upon these Clinometers, &c., gives the value of any angle, as follows:—The angle having been ascertained from the divided arc upon the instrument, refer to that degree in the column marked *Angle*, and opposite, in another column, will be found the rise or fall in any given measured distance; for instance, say the degree shown on the divided arc is 18, opposite to this number on the scale is 3, this indicating one part rise or fall in three, or one mile in three miles, one foot in three feet, &c., &c.

No.	Description	Each. £ s. d.	Each. £ s. d.
631	**Geological Compass,** for ascertaining the dip or inclination of strata, hills, &c., with index, showing the inclination in degrees and inches per yard, in square mahogany box, 4½ inches		0 10 6
632	Ditto ditto, 3 inches		0 7 6
633	Ditto ditto, 2½ inches		0 7 0
	631 to 633, if with best Bar Needles, 2s. 6d. each extra.		
634	**Geological Compass,** brass mounted, with best bar needle and leather case (fig. 634) . . . .. 30s.	2 2 0	2 10 0
635	Ditto, ditto, large size, full divided and best finished, in Pocket Case		4 4 0

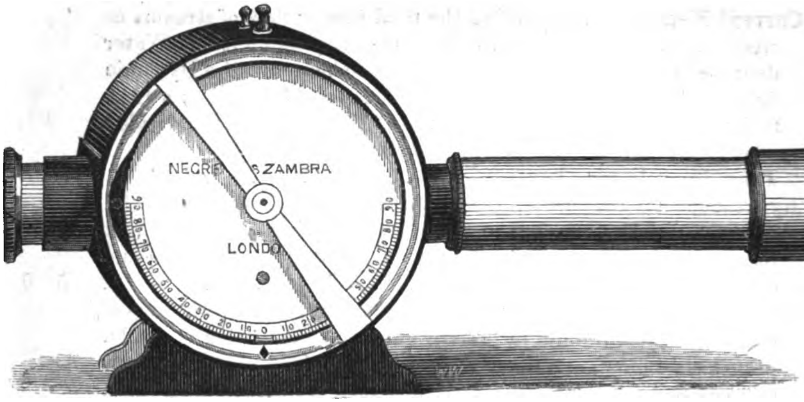


FIG. 636.

636 **Pocket Alt-Azimuth Instrument,** improved by Francis Galton, Esq., F.R.S. A most convenient and portable instrument for obtaining in a ready manner Angles, Levels, &c., similar to Nos. 606 and 608. The Telescope renders this instrument available for observing at a considerable distance from the Station, either Magnetic Bearings, Horizontal or Vertical angles, &c. &c. Price in case, as fig. 636. £6 6 0

637 **Pocket Alt-Azimuth** without Telescope £5 10 0

The Alt-Azimuth, fig. 636, is a combined Compass and Pendulum or Wheel Clinometer. On one side of the instrument is the Compass needle, carrying an Aluminium ring, divided on its surface into degrees similar to the Prismatic Compass; this ring is also divided upon *its edge*, so that compass bearings can be noted in the usual manner, or read off through the Telescope. On the reverse side is the Dial of the Clinometer Wheel with a semi-circle of divisions, similar to those found on a Clinometer Compass, showing gradients, &c., in degrees. This dial also has its edge divided into degrees, by which Vertical inclinations or angles can be ascertained by this Clinometer Wheel, either with or without the Telescope; the special use of the Telescope being for distance. Our wood-cut shows the Clinometer side of the instrument, with the Telescope as drawn out for use, this Telescope has suitable adjustments for varying sights and distances. The screws seen on the top of the box are for releasing or fixing the Compass and Clinometer.

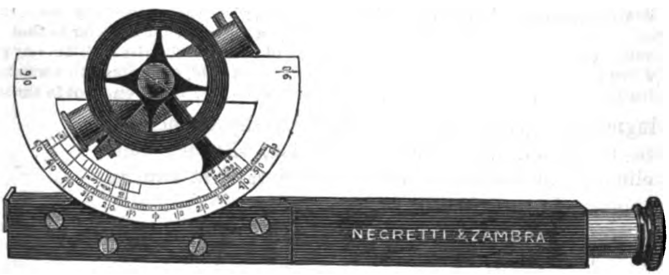


FIG. 638.

638 **Abney's Contouring Reflecting Level or Pocket-Altimeter.** Improved form with divided Arc to show gradients, &c. (fig. 638.) Price in case . £2 2

Fig. 636 and Fig. 638 are very nearly the actual size of the instruments described above.

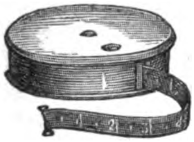


FIG 656.

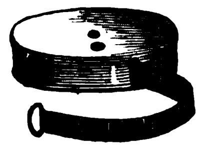


FIG. 655.

FIG. 652.

FIG. 644.

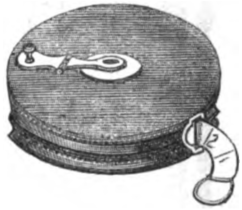


FIG. 651.

LAND MEASURING CHAINS, TAPE, MEASURES, ETC.

No.	Article	Each. £ s. d.	Each. £	s.	d.
639	**Land Chain,** Iron, 50 feet, and 10 Arrows		0	11	6
640	Ditto ditto, 100 feet, and 10 Arrows		0	14	6
641	**Land Chain,** 100 feet, best Steel Wire with ditto . .		1	2	0
642	**Gunter's Iron Measuring Chain,** sixty-six feet, or four poles in length. Light wire		0	12	6
643	Ditto ditto, Stouter, Galvanized		0	15	0
644	**Gunters' Iron Measuring Chain,** *best* quality, Steel Wire, with three sawed oval rings between each link, and swivel in middle, and stout Brass swivel handles and marks—Galvanized (fig. 644)		0	18	6
645	**Twenty-metre Chain, Centimetre links,** best make .		0	18	6
646	**Arrows, set of Ten Steel wire, Pointed and Numbered for ditto,** 15 inches long and 1¾-inch eye . . .		0	3	0
647	**Standard Chain,** 100-feet		10	0	0
648	Ditto ditto 50-feet		5	5	
649	Ditto ditto 66-feet		7	7	0

---

650 **Measuring Tapes,** common, Leather cases :

Length . .	33-feet.	50-feet.	66-feet.	100-feet.
Price . .	4s.	5s. 6d.	6s. 6d.	10s. 6d.

651 **Measuring Tapes,** in japanned Leather case, with folding handle, rollers, &c. :—(fig. 651.)

Length . .	33-feet.	50-feet.	66-feet.	100-feet.
Price . .	5s. 6d.	6s. 6d.	8s.	11s.

652 **Best easuring Tapes,** multiplying winder, in best **Patent** black or brown solid Leather case folding handles, rollers (fig. 652) :—

Length		40-ft.	50-ft.	66-ft.	80-ft.	100-ft.
Price	8s. 6d.	9s. 6d.	11s. 6d.	12s. 6d.	14s 6d.	21s.

653 **Ordnance Pattern 50 feet Measuring Tape,** divided into feet, and inches, and yards, and 1-10ths, and 1-100ths, leather case, folding handle and rollers . . . 0 12

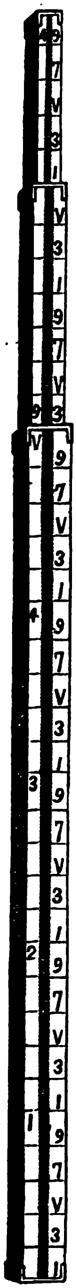


Fig. 664.

654 **Patent Elastic Steel Tapes,** leather case, flush handles, marked with links at the back—33-feet, or 2 poles . 1 3 0
66-feet, or 4 poles . 2 0 0

655 **Patent Pocket Spring Measuring Tapes,** in brass case, (fig. 655) 3-feet 2s. 6d., 0 3 6 0 4 6
6-feet 5s. 6d., 0 7 0 0 9 0

656 **Patent Elastic Steel,** ditto—3-feet 0 6 6
(fig. 656) 6-feet 0 8 6
9-feet 0 12 0

657 **Pocket Spring Tapes,** in German silver cases, with stops and rollers, English yard, and French metre, 3-feet, 6-feet, and 9-feet . . 5s. 6d., 7s. 6d. 0 10 6

658 **20 Metres (French)** best tape measures in hard leather cases with folding handle 0 15 0

659 **20 Vara (Spanish)** ditto ditto 0 15 0

Measuring Tapes made to order with French, Spanish, or Portuguese and other Scales in various lengths and mountings.

660 **Levelling or Station Staff,** common form . . . 1 10 0

661 **Sopwith's Station Staff,** 14-feet improved three jointed, best socket fittings, each 3 3 0 per pair 6 6 0

662 Ditto ditto, **best painted** scale, sliding in three lengths, put together with brass screws, mountings and springs (fig. 664) each 3 15 0 per pair 7 10 0

663 **Station Staff,** 14-feet three joint **half-round Ordnance pattern,** per pair 7 10 0

664 **Levelling Staves.** Lieut.-Col. Strange's arrangement for Indian Service.

1. The foot is divided into alternate black and white spaces, each representing half a tenth of a foot. At short distances the observer will easily subdivide these into fifths, that is into hundredths of a foot, which is the smallest quantity recorded in ordinary levelling.
2. The arrangement is such that all the figures, both those indicating the feet and those indicating tenths of a foot, are on the same side of the scale. The object of this is to obtain more ground surrounding the figures, as on this condition their visibility in a great measure depends.
3. The forms of the figures have been carefully studied. It will be noticed that the figures denoting tenths of a foot, are small. It was found that those usually employed are needlessly large. The larger they are the more difficult it is for the eye to separate them. The size now adopted is the result of trial at 10 chains, at which distance they can be easily read with a good 14-inch level telescope.

An angular pointer at one end of each of the black spaces of the scale indicates the extremity of the space to which the adjacent figure refers.

As inverting telescopes are now invariably used for levelling instruments the figures are so arranged that they shall appear erect in such a telescope.

Price per pair, £8 8 0

665 **Papers for Level Staves,** . . . . . per foot 0 0 3

666 **French Pattern Station Staves,** 4-Metres long with plain metal mountings . . . per pair 3 3 0 4 4 0

667 Ditto ditto, 5-Metres fully divided scale, and inverted figures with best brass mountings 5 5 0

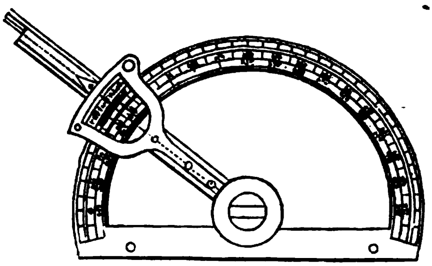


FIG. 679.

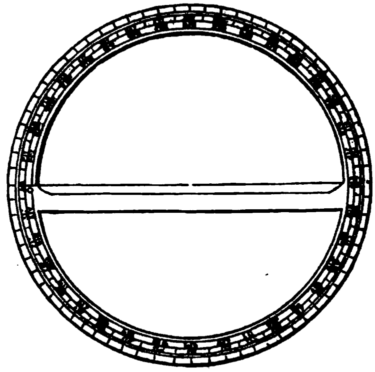


FIG. 680.

ORDNANCE PATTERN MEASURING RODS, SCALES, &c.

No.	Description	Each. £	s.	d.
670	**24-inch Scale, Boxwood,** 25 inches long, 1$\frac{3}{4}$ broad, square at the edges, having 1 and 2-inch diagonal scales on two edges, the inch in tenths and eighths, the foot into decimal parts, and a scale of chords to a radius of 12-inches to be used with Beam Compasses .	0	10	6
671	**Architects' Scale, Boxwood,** 12$\frac{1}{2}$-inches long, 1$\frac{1}{4}$-inch broad, with the inch and half-inch to a foot on one edge, and the quarter and three-quarters to the foot on other edge	0	4	0
672	**Surveying Scale Boxwood,** 12$\frac{1}{2}$-inches long, 1$\frac{1}{4}$-inch broad and chamfered alternately, with diagonal scales, and scales on the edges, also scales of yards and paces to 2, 4, and 6 inches to a mile	0	4	0
673	**10-feet Rod,** 1$\frac{1}{4}$-inch square deal painted, divided into feet and quarters on all sides, and figured from both ends alternately, shod with brass	1	0	0
674	**Link Staff,** 1$\frac{1}{4}$-inch square, deal painted black, divided into 10 links on all sides, the centre division marked with a star, shod with brass.	0	12	6
675	**5-feet Surveyor's Measuring Rods,** lance wood, tipped with brass, divided on one side into feet and quarters, and on the other into feet, inches, and one-eighths	0	8	6
676	**2-feet Rule, Boxwood,** 4-fold gun and shot gauge, and the inch divided into 10, 8, and 12 parts	0	12	
677	**Standard Measure, Yellow Deal,** 43 inches long, 2$\frac{1}{2}$-inch wide, $\frac{1}{2}$-inch thick, with edge bar along the middle, with four brass plates let in; on the top and edge of one side, 3 standard feet are accurately marked off, and on the other sides two brass plates marked, 5 standard links. In a deal case	1	10	0
678	**Levelling Staff,** 14-feet, mahogany sliding in 3 lengths, with brass spring and fittings, painted scale, as No. 664			
679	**Protractor Semicircular,** brass, 6-inch, figured to 180° and to 360°. The arm 6$\frac{1}{2}$-inch long, with vernier reading to minutes with clamp screw, and magnifying glass in mahogany case, both sides of the arm parallel to the centre and zero (fig. 679)	3	3	0
680	**Protractor Plain Circular,** brass, 8-inch, figured outside to 360°, and inside each quarter to 90°, divided to half-degrees. In mahogany case (fig. 680)	2	2	0

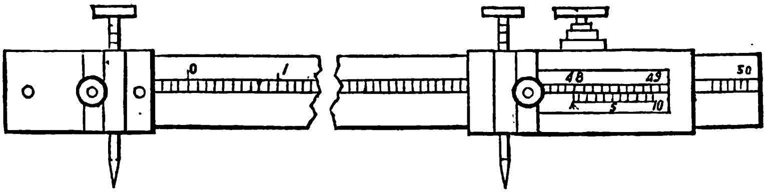


FIG. 681.

No.		£	s.	d.
		Each.		
681	**Beam Compass,** mahogany beam inlaid with holly, graduated to 50 inches, vernier reading to $\frac{1}{100}$ inch. 48 inches between the points, ink and pencil points and clamping screws, in deal case (fig. 681) .	3	12	6
682	**T Square,** mahogany 12 by 45 inches having the stock and blade flush on one side	0	12	0
683	Ditto ditto 12 by 52-inch	0	16	0
684	**Angles,** 6-inch, pear-tree, set square 45°	0	2	0
685	Ditto 9-inch ditto ditto 30°	0	3	0
686	**Straight Edge, Steel,** best London make, 2 inches wide, 42-inch, in deal case	1	4	0
687	Ditto ditto ditto 52-inch, in ditto	1	10	0
688	**Parallel Rules,** 15-inch, best **Ebony rolling,** plain edges	0	16	6
	Ditto ditto 12-inch ditto ditto	0	12	6
	Ditto ditto 9-inch ditto ditto	0	10	6
689	Chain 100 feet with 3 oval rings between each link, stout brass marks, best stout iron	1	2	0
690	Ditto ditto four, Pole Gunter's	0	18	6
691	Arrows, set of 10 by 14-inch, 1¾-inch eye	0	3	0
692	**Dark Glass Horizon,** in Brass Frame with 3 adjusting screws and Spirit Bubble ground on one side, in Mahogany Box	2	5	0

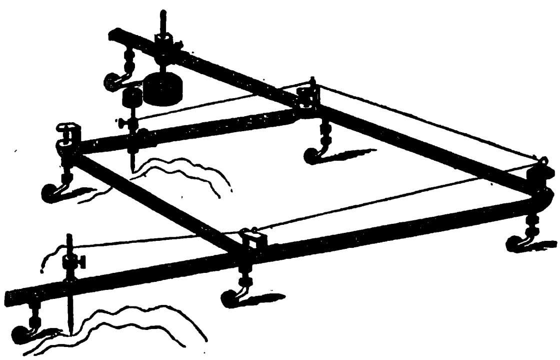


FIG. 693.

No.		£	s.	d.
693	**Pentagraphs,** in **Brass,** of the best construction, for reducing or enlarging plans to any proportion :—			
	18-inches . . . . from	6	10	0
	24-inches	7	7	0
	30-inches, Ordnance size and pattern with improved Leg and Wheel	8	10	0
	36-inches	10	10	0
	48-inches (fig. 693)	12	12	0

No.	Article		£	s.	d.
			Each.		
674	**Pentagraphs,** Ebony	from	5	0	0
675	Ditto, common White Wood		1	5	0
678	**Centrolinead,** for drawing buildings, &c., in perspective, the instrument giving the line of direction of the vanishing point		3	3	0
679	**Elipsographs,** for striking Ovals	3 3 0	5	5	0
680	**Diagraph,** by which near or distant objects viewed through a telescope can be drawn upon a sheet of paper by the movement of the Telescope		20	0	0
681	**Planimeter,** Amsler's Patent Brass for computing areas		3	15	6
682	Ditto ditto, German Silver		4	12	6
683	**Eidograph,** capable of reducing any proportion from 1 to 6-inches in box complete	£11 0 0 12 12 0 and	15	0	0
683*	**Computing Scale.** Universal, as used by H.M. Tithe Commission Office, containing 1, 2, 3, 4, 5, 6 chains to the inch, and 6-inches and 5 feet to the Mill in Mahogany box		3	12	
683†	Extra Scales fitted to above		0	5	6
683‡	**Computing Form Papers,** 10, 20, 30, 40, 50, or 60 per sheet		0	5	0

FIG. 683B.

FIG. 683E.

No.	Article		£	s.	d.
683A	**Opisometer or Map Meter,** for measuring Curved lines on Plans or Charts, &c.		0	3	6
683B	Ditto Ditto Improved, fig. 683B	4s. 6d.	0	5	6

683C **Chartometer** for measuring and registering distances on Maps. The Chartometer is about the size of a watch, with a small wheel partly projecting from the lower end of the case. To measure any line, the instrument is held upright, and the little rolling wheel is run along the line to be measured; as the wheel advances an index hand registers on a dial the distance passed over in miles, yards, &c., according to the scale of the map. It can be used for maps of different Scales by a simple substitution of one dial plate for another, a variety of those adapted to the ordnance measurements being contained in the case which holds the instrument.

No.	Article	£	s.	d.
683D	**Chartometer** with Set of Dials, in neat Leather Case	1	1	0
683E	Ditto ditto German Silver Plated, complete in Case (fig. 683E)	1	12	0
683F	Ditto ditto Gold Plated best finish, complete in best Case	2	2	0
684*	**Morriss's Measuring Instrument,** in Brass	0	10	6
	Ditto ditto in Leather Case	0	12	6
	Ditto ditto German Silver and Electro, in Leather Case	0	16	6

These instruments measure straight lines, in feet, inches, and fractions.

No.	Article	£	s.	d.
683G	**Goniometer, Wollaston's Reflecting,** for measuring the Angles of Crystals	5	5	0

For further particulars of Drawing Instruments, Rules, Scales, &c., see Section Mathematical Drawing Instruments.

ESTIMATE FOR A SET OF

ORDNANCE-PATTERN SURVEYORS' AND ENGINEERS INSTRUMENTS,

AS SUPPLIED BY NEGRETTI AND ZAMBRA FOR GOVERNMENT SERVICE.

A 5-inch best Theodolite, divided on **Silver**, with Tripod Stand, as fig. No. 536, £24.

A 15-inch Dumpy Y Level, with ditto, ditto, as fig. No. 566 £18 18s.

Pocket Compass, 3½ square, mahogany box. 2 circles of divisions one 360° the other figured 4·90°. Best bar needle, 16s.

Surveying Cross, round, on Ash staff, as fig. No. 590, 12s. 6d.

Drainage Level, with Tripod Stand, fig. 556 £5 5s.

A 4-inch Circumferenter, folding sights, ball and socket joint, with jointed tripod stand, as fig. No. 579 £7 7s.

Ordnance Pattern Drawing Boards:—

Antiquarian .	55 by 33 inches.	Atlas . .	37 by 28 inches.
Double Elephant	43 by 29 „	Imperial .	32 by 24 „

Prices various.

Prismatic Surveying Compass. 3-inch card, with Silver ring, in *Pocket* case, as No. 596 £3 10s.

Best Pocket Sextant with Telescope, divided on Silver arc £5 5s.

Leather Case and Strap for ditto, 12s.

100 feet best Stout Chain, Brass handles, &c., as No. 641, £1 2s.

4-pole best Gunter's ditto ditto, as No. 644, 18s. 6d.

1 set 10 14-inch Arrows with eye 1¼ inch diameter as No. 646, 3s.

1 case of Brass Drawing Instruments:— £2 10s. and £3 3s.

Mahogany box with Tray containing 6-inch ivory scale, 6-inch ebony parallel rule, 6-inch compasses with pen and pencil point, lengthening bar, pen and pencil bow, large and small ivory handle, drawing pens, set screw, 6 drawing pins, &c.

Mercurial Horizon, complete in box £3 3s.

6-inch Sextant divided on Silver to 10 seconds, with plain tube, two Telescopes with additional power and dark glasses in mahogany case, £10 10s. and £11 11s.

Tripod Stand for ditto, with jointed legs £3 3s. and £5 5s.

30-inch brass Pentagraph as fig. 693 in mahogany box, £7 10s.

Mountain Barometer in solid Leather case and brass stand, as No. 609*, £8 8s.

Aneroid Barometer or Orometer, as No. 611, for Altitude measurements, £8 8s.

Pocket Thermometer, Oval Boxwood, 7-inches long, 0 to 140° Fahrenheit and Centigrade Scales.

Altitude Tables for use with above, sent with each instrument.

Boiling Point Apparatus and Tables, see page 70.

NAUTICAL INSTRUMENTS.

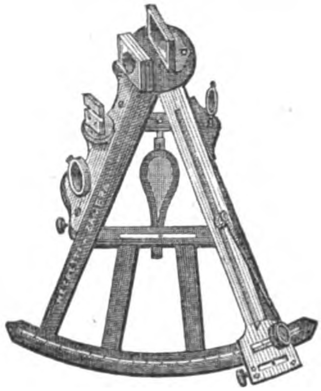


FIG. 69.

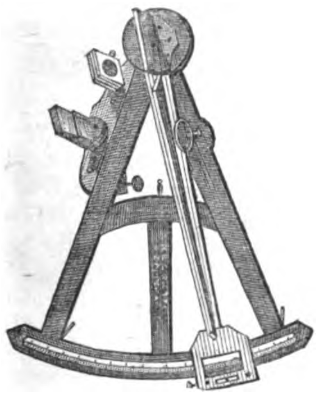


FIG. 688.

FIG. 686.

QUADRANTS OR OCTANTS.

		Each. £ s. d.	Each. £	s.	d.
685	**Ebony Quadrant,** in oak case		2	2	0
686	Ditto ditto, with Tangent screw to index (fig. 686). .		2	10	0
687	Ditto ditto, with two Tangent screws		3	0	0
688	Ditto ditto, with bar to index and vertical screw (fig. 688)		3	3	0
689	Ditto ditto ditto, with six shades		3	10	0
690	**Telescope** to above, extra		0	6	6
691	**Handle Ebony Quadrant,** best quality, with two telescopes, divided to 30 seconds, long centre and seven shades, in mahogany box (fig. 691) . . .		5	0	0
692	**Metal Quadrant,** best quality, divided on Ivory, with achromatic Telescopes, long centre, seven shades, and index magnifier, in mahogany box		5	5	0
693	**Metal, Handle Quadrant or Half Sextant,** best quality, divided on **Silver,** with achromatic Telescopes, long centre, seven shades, and index magnifier, in mahogany box		6	6	0

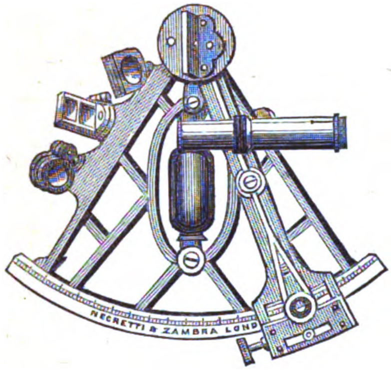


FIG. 700.

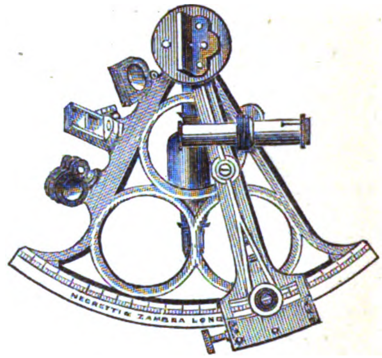


FIG. 695.

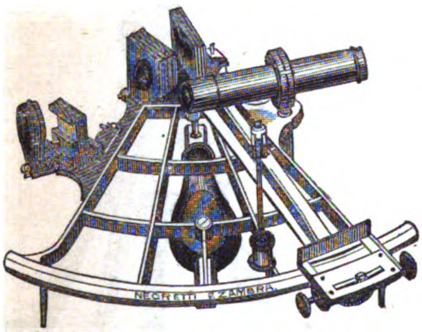


FIG. 700*.

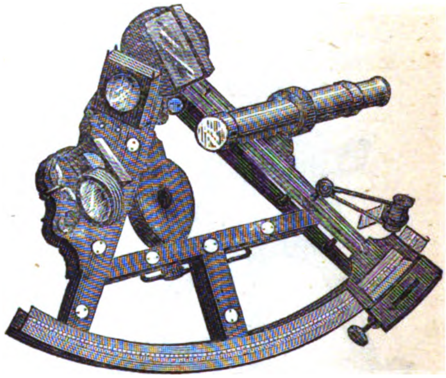


FIG. 701.

SEXTANTS.

No.	Description	Each. £	s.	d.	Each £	s.	d.
694	**Ebony Sextant,** 8-inch, best, with Ivory arch Achromatic Telescopes, &c., in mahogany case				6	10	0
695	**Metal Sextant,** 6-inch, Circular pattern, divided on Silver to ten seconds, three Telescopes, in mahogany case (fig. 695)				8	8	
696	**Metal Sextant, best** 6-inch (Cadets'), Triangular pattern, divided to 10 seconds on Silver, extra power to Telescope, strapped horizon adjustments in Box				10	10	0
697	**Metal Sextant,** 8-inch, Edge bar pattern, bronzed limb divided on Silver to ten seconds, in mahogany box				9	9	0
698	**Metal Sextant,** 8-inch, Oval pattern, bronzed limb divided on Silver to ten seconds, and glass reflector to vernier				11	11	0
699	**Metal Sextant,** Oval, Triangular, or other patterns, best, bright or bronzed limb, Neutral Tint Shades, and extra power for Telescopes, &c., in polished mahogany case with screwed fittings				12	12	0

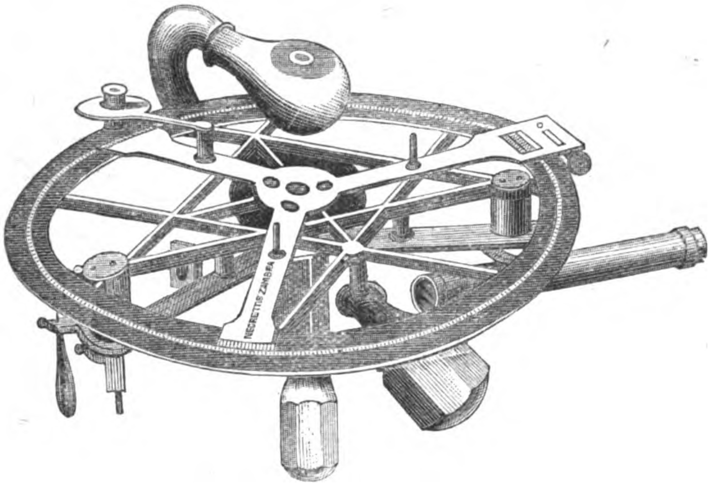


FIG. 704.

700 **Metal Sextant,** 8-inch, best Edge Bar or Triangular Pattern bridge handle, divided on Silver to ten seconds, bright or bronzed limb, cup and ball tangent screw, swing horizon, and capped adjustments, Neutral Tint Shades, and extra power to Telescopes, and of the most accurate finish, and with all recent improvements, in mahogany case (fig. 700) Price, 13 13 0

701 **Pillar or Double Plated Sextant,** divided to ten seconds, with additional power to telescope, and Reflectors to verniers, &c., of the very best quality, in polished mahogany case (fig. 701) 17 17 0

702 Gold or Platinum Arch to either of above 2 12 0

703 **Reflecting Circle** (Troughton's), 10-inch 25 0 0

704 Ditto ditto, 12-inch (fig. 704) 30 0 0

This instrument perfectly corrects the error of the centre by the readings of the three branches of the index; this property, combined with that of observing both ways, reduces the errors of dividing one-sixth part of their simple value. With this Circle angles may be measured as far as one hundred and fifty degrees.

705 **Tripod Stands for Sextants,** with jointed legs, horizontal and vertical action and Clamping Screw, in deal case £4 4 0 5 5 0

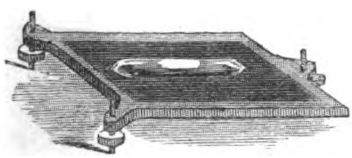


FIG. 710.

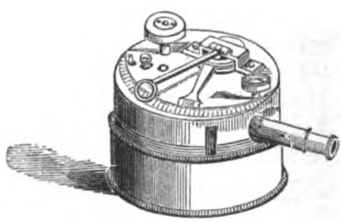


FIG. 707.

POCKET SEXTANTS.

706 **Pocket or Box Sextant,** with Rack-work adjustment . 4 4 0

707 **Pocket Sextant,** best quality, divided on Silver, with Telescope and tangent adjusting screw, &c. (fig. 707) . 5 5 0

708 Ditto ditto with Cover divided for difference of Hypothenuse and Base 5 15 0

709 **Leather Case and Strap** for above 0 12 0

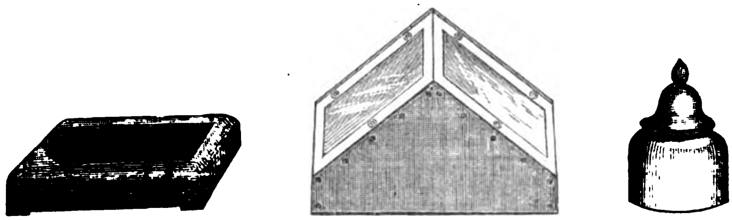


FIG. 712.

ARTIFICIAL HORIZONS.

No.		Each. £	s.	d.
710	**Black Glass Plane, or Artificial Horizon,** with three levelling screws, and Spirit Level in box (fig. 710) .	2	10	0
711	**Artificial Horizon,** with Wood Mercury bottle and trough	3	10	0
712	**Artificial Horizon,** Ordnance pattern, with two troughs, turned Iron Mercury bottle, complete in mahogany box (fig. 712)	4	10	0

QUADRANT AND SEXTANT GLASSES, &c.

No.		£	s.	d.
713	**Horizon Glasses** for Quadrants . . . . per doz.	0	15	0
714	**Index** ditto for ditto	1	4	0
715	**Coloured Shades,** for ditto . . . per set of 7	0	14	0
716	**Horizon Glasses** for Sextants . . . . . per doz.	1	10	0
717	**Index Glasses** for ditto	3	0	0
718	**Neutral Coloured Shades,** best parallel per set of 7 .	1	8	0
719	**Sets of 3 Achromatic Telescopes** for Sextants, best .	1	10	0
720	Extra Power for ditto	0	10	0
721	**Horn Magnifiers** . . . . per doz.	0	15	0

Quadrants or Octants and Sextants can be supplied of an inferior quality, at slightly lower prices, but they cannot be recommended as correct.

SUN-DIALS.

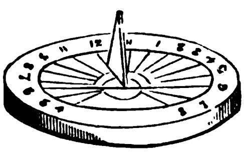


FIG. 722.

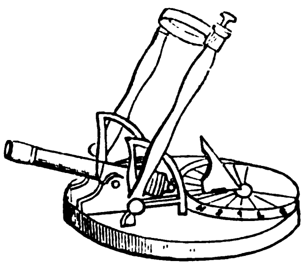


FIG. 731.

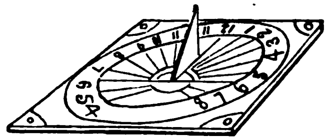


FIG. 724.

722 **Sun Dials,** with circular Brass slab and style (fig. 703) :—

Diameter .	6-in.	8-in.	10-in.	12-in.	14-in
Price .	42s.	50s.	63s.	100s.	120s.

723 **Sun Dials,** circular, best Brass, full divided to 5 minutes, with Equation table, and handsomely engraved (fig. 723) :—

Diameter . .	10-in.	12-in.	14-in.	18-in.
Price . .	84s.	115s.	100s.	263s.

724 **Sun Dials on Slate,** the style of Brass, 12 inches Square (fig. 724) 2 5 0

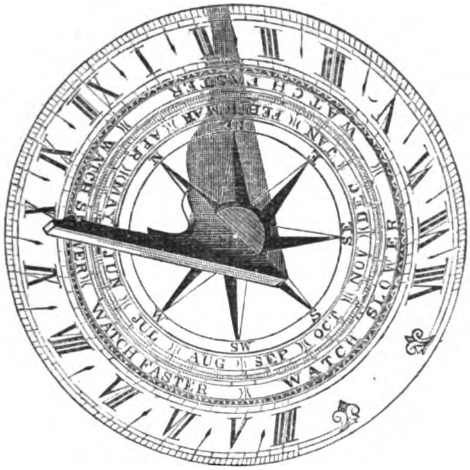


FIG. 723.

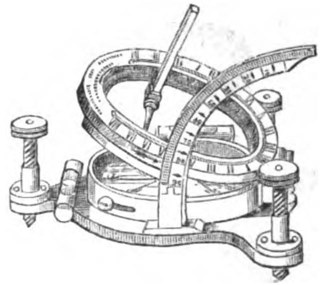


FIG. 729.

No.	Description	Each. £ s. d.	Each. £ s. d.
725	**Sun Dials**, 12-inch, Plain divided on white Marble, with brass style		2 15 0
725*	Ditto, 15-inch, divided to 15 minutes, with **Equation Table**		5 5 0
726	**Universal Joint Sun Dial and Compass**, with divided arc, in cases 2½-inches		3 3 0
727	Ditto ditto, ... 3½-inches		4 4 0
728	Ditto ditto, ... 4½-inches		6 6 0
729	**Universal Sun Dial and Compass**, for both North and South Latitudes, 2½-inches, with **Levels** and Adjusting Screws, in leather case (fig. 729)		4 4 0
730	Ditto ditto, 4½-inches, best mounting and dividing		7 7 0
731	**Sun Dial**, with burning lens so arranged that the Sun's rays are thrown on the priming of a small loaded Cannon, and cause it to be fired at noon precisely. The mounting of the lens has a scale corresponding to the sun's declination for every week in the year (fig. 731)		3 3 0

These dials are constructed for the latitude of London. If required for other localities they must be made specially to order, and will be slightly increased in cost.

SHIPS' OR POCKET COMPASSES REPAIRED AND ADJUSTED.

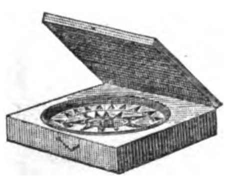


FIG. 734.

FIG. 746.

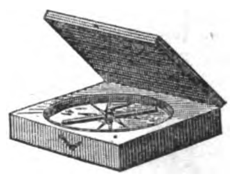


FIG. 733.

POCKET MARINERS' COMPASSES.

No.	Description		£ s. d.	£ s. d.
732	**Pocket Compasses**, plain needle, in square mahogany cases, with stops	3s. 6d. 4s. 6d.	0 5 6	0 6 6
733	Ditto ditto, mounted with best Bar Needles and Agate centres (fig. 733)	6s. 6d. 7s. 6d.	0 10 6	0 12 6
734	Ditto ditto, mounted with floating Card and Agate centres (fig. 734)	6s. 6d. 7s. 6d.	0 10 6	0 12 6
735	**Small Pocket Compasses**, Round metal cases . .	2s.	0 2 6	0 3 6
736	Ditto **Compasses** for the Watch Chain . .	1s.	0 1 6	0 5 0

No.	Description	Each. £	s.	d.	Each. £	s.	d.
737	**Trinket Compasses,** Silver and Gold cases, best mounted either with Needle or Card dials (see page 215) 21s., 30s.	2	2	0	3	3	0
738	**Brass Gilt Pocket Compasses,** in leather cases, plain needle, and paper dial . . . . . 6s. 8s. 6d.	0	10	6	0	12	6

FIG. 750.

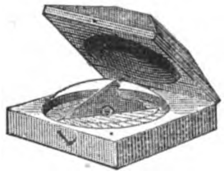


FIG. 746*.

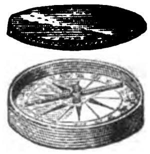


FIG. 741.

No.	Description	£	s.	d.	£	s.	d.
739	**Pocket Compasses,** with **Enamelled dials,** in Strongly Gilt Plated metal or German silver cases, best Bar Needles, or Floating Cards, with Agate centres and stop, in hinged leather case (figs. 739, 739*) 15s., 18s. 6d,	1	1	0	1	10	0

These Pocket Compasses are very highly recommended for use in moist tropical climates. The Dials being enamelled similar to a watch-face, will always remain clean and readable, where silvered metal or card would become tarnished or obliterated.

No.	Description	£	s.	d.	£	s.	d.
740	**Pocket Compasses, in Circular Brass boxes and cover,** with magnetic needle, or floating card, with stop 6s. 6d., 7s. 6d.,	0	10	6	0	12	6
741	Ditto ditto, and Agate centre, with Bar Needle (fig. 741) . . . . 12s. 6d.	0	15	0	1	1	0
742	**Watch Compasses,** in Silver Hunting Cases (figs. 742, 742*)	2	10	0	3	3	0
743	Ditto ditto . . . . . . German silver, 32s.	2	2	0	2	10	0
744	**Pocket Sun Dial Compasses, in oblong boxwood case,** with equation table				0	11	0
745	Ditto with best Bar Needle ditto (fig. 745)				0	12	6
746	**Sun Dial Compasses,** in common round wood case (fig. 746)				0	2	6
	Ditto ditto, superior make, agate centre				0	11	0
	Ditto ditto, in Square Wood case, best mounting (fig. 746*)	0	12	6	0	15	0
747	Ditto ditto, **Round Metal Case,** with cover with stop				0	12	6
748	Ditto ditto, German silver plated (fig. 748) . . .				0	16	6
749	**Starlight or Moonlight Compasses,** with transparent glass dial, and large bar needle, for the use of travellers by night, or by the light of a match, cigar, &c., held beneath it, in hinged leather case . . .				2	2	0

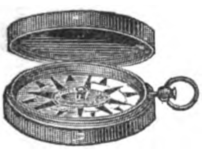


FIG. 739*.

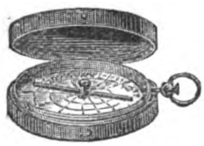


FIG. 739.

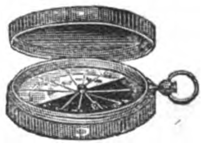


FIG. 739.

No.	Description	£	s.	d.	£	s.	d.
750	**Singer's Patent Compasses, with floating Pearl or enamelled Card dials,** one-half of the compass card being **Black;** the points are ascertained with great ease in the darkest night in the open air. Pocket sizes in various metal mountings, from (figs. 750 and 739). See also No. 12s. 6d., 16s. 6d.,	1	1	0	1	12	0


FIG. A.


FIG. B.


FIG. C.


FIG. D.

750† **Magnetic Trinket or Charm Compasses,** mounted in **Gold** and **Silver** in great variety of forms, as shown in figs. A to M, including the new **Transparent Pebble**


FIG. E.


FIG. F.


FIG. G.


FIG. H.

Mountings (figs. F and G), the Needle being poised between the two **Pebbles.** These Pebbles are so worked upon their surfaces as to form a **Magnifying Lens**


FIG. 742*.


FIG. K.

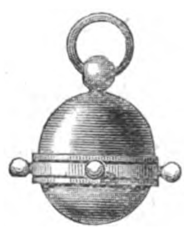


FIG. L.


FIG. M.

or **Burning Glass.** These Prices vary with the quality of the Gold or Silver and the design of the frame. Fig. A 60s.; fig. B 70s.; fig. E 70s.; fig. F 29s.; fig. G 32s.; figs. K and L 50s. and 55s.; fig. M 63s.

No.	Description	Each. £ s. d.	Each. £ s. d.
751	**Gregory's Compass for Equestrians,** the Needle or Card being mounted on two centres to prevent oscillation, plain mount	1 1 0	1 15 0
752	Ditto ditto, best mounted in Silver hunting case, watch form (fig. 752)		2 2 0

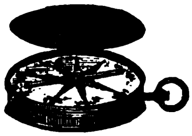


FIG. 752.

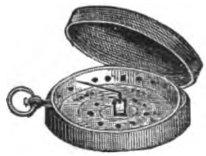


FIG. 753.

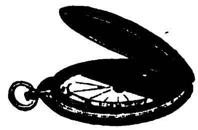


FIG. 742.

No.	Description	Each. £ s. d.	Each. £ s. d.
753	**Oat Beard Hygrometer,** or Pocket Damp Detector, a simple and sensitive little instrument for ascertaining the comparative dryness of apartments, beds, &c. Strongly gilt in morocco case (fig. 753)	0 10 6	1 1 0

FIG. 748.

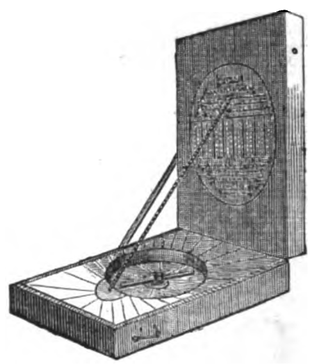


FIG. 745.

BOAT AND SHIPS' COMPASSES.

No.	Description	Each. £ s. d.	Each. £ s. d.
754	**Boat Steering Compass,** Plain mounted, 5-inch, in square Oak box with slide lid	0 13 0	0 16 6
755	**Brass Cone Boat Compass,** in turned Wood case (figs. 755, 755*)		0 14 0
756	**Boat Compass, Round Brass Box,** in jimbals . . .	1 5 0	1 12 0
757	Ditto, ditto Square Oak Box, with jimbals . . .		1 10 0
758	Ditto ditto Best Mounted (fig. 758)	1 16 0	2 2 0
759	Ditto ditto Polished Mahogany hinged box with Singer's Card (fig. 759)		2 2 0

FIG. 759.

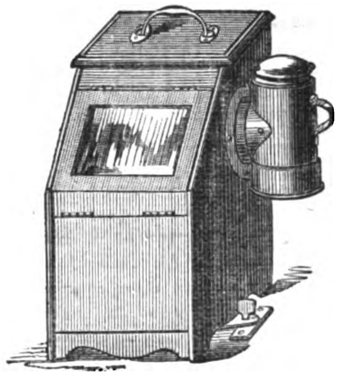


FIG. 760.

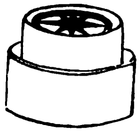


FIG. 755.

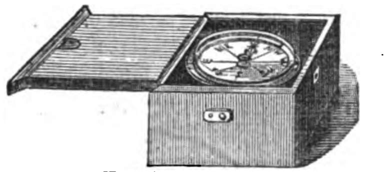


FIG. 758.

FIG. 755*.

760 **Improved Yacht or Boat Compass,** with **Singer's** Patent or Ordinary Card with or without Binnacle or Lamps (figs. 761 and 759).

Size of Compass Box.	Diameter of Card.	Price of Compass complete.	Price of Compass with Binnacle.	Price of Compass. with Binnacle & Lamp.
		£ s. d.	£ s. d.	£ s. d.
No. 1—4½ inches square	2½ inches.	0 14 0	1 14 0	2 16 0
No. 2—5½ do. do.	3 „	0 16 0	2 0 0	3 3 0
No. 3—6½ do. do.	3½ „	0 18 0	2 6 0	3 10 0

These Compasses are constructed expressly for Yachts, Boats, &c., and are of the best quality. They are in polished mahogany cases, with brass jimbal rings and copper bowls. The cards are also balanced on jewelled centres, so as to give the least amount of friction possible. The Compasses being complete in boxes, they can be taken in and out of binnacle at pleasure.

The Binnacles (fig. 760) are also of polished Mahogany with Glass fronts, Brass Lamps, and are furnished with plates and bolts for securing to deck, so that they can be fixed or removed in a few moments.

"The advantages to be derived from Singer's Night Compass Card are manifold. For instance, it is often of the utmost importance when reconnoitreing the position of an enemy in the night to do so with secrecy. On such occasions a light dare not be shown without running a great risk, and a compass that can be read in the dark will be invaluable on such hazardous occasions. Also in steering small craft in heavy gales of wind, when it is a matter of life and death for the helmsman to be able to watch the sea and to avoid it as much as he can, this night compass will prove a great boon. It will enable the steersman to look into the dark masses of heaving waters, and see all surrounding objects at a glance, a thing impossible with the present compass, in consequence of his eyes being blinded with the glare of the binnacle light. For Sportsmen (particularly wild-fowling), Travellers, and Tourists who may be overtaken by night or in a mist, a compass that can be carried in the waistcoat pocket, and which can be read in the dark without a light, may often be instrumental in

guiding the wayfarer to where he may expect to obtain shelter ; for it often happens that travellers and others, though they possess a Compass, yet may not have the means of getting a light, or if they have a match, either the wind or the rain may prevent them using it."

SIR, Pilot Cutter *Agenoria*, No. 14, Portsmouth, *November 7th*, 1861.

We, the undersigned Trinity Pilots, beg to inform you that we have had a fair trial of your Patent Compass against the old card, having had it at sea seven days and nights. We therefore willingly bear testimony to its superiority over the old compass card, and that the course can be made out in the darkest night in the open air, without the aid of artificial light. It is so far superior, that the course can be seen by your patent when we could not see the ordinary card at all.

JOSEPH HARDING, *Queen's Pilot, Dockyard, Portsmouth.*
JOHN COOTE, } *First Class Trinity Pilots.*
WILLIAM MAIN, }

No.	Article	Each. £ s. d.
761	**Brass Box Compass,** with Captain Kater's Azimuth **Sights,** Floating Card, 3-inch, with cover . . .	1 10 0
762	**Ship's Steering Compasses,** in Wood box :—	

Inches .	7.	8.	9.	10.	11.	12.
Price, each	8s.	9s.	10s.	11s.	12s.	14s.

FIG. 763.

FIG. 767.

763 **Ship's Steering Compasses, best make** Agate, cap to needle, with **Brass** bowls in gymbals, and oak box outside (fig. 745) :—

Inches .	7.	8.	9.	10.	11.	12.
Price, each	15s. 6d.	16s. 6d.	18s.	20s.	22s.	25s.

No.	Article	£ s. d.
764	**Storm Compasses,** 10-inch	1 10 0
765	Ditto ditto 11-inch	1 14 0
766	**Storm Compasses, double dipping Needles,** best mounted, 10-inch, Transparent Storm card	2 10 0
767	Ditto ditto „ 11-inch (fig. 767) .	2 15 0
768	**Amplitude Compass,** brass caps, and steel centres, **with Sights,** agate, 11-inch	1 16 0
769	Ditto ditto, 10-inch	1 10 0

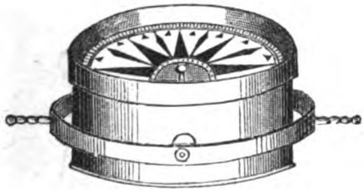


FIG. 771.

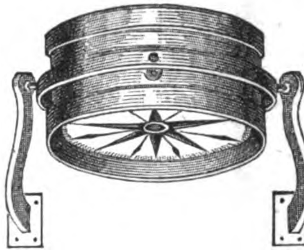


FIG. 772.

No.	Description	Each. £ s. d.	Each. £ s. d.
770	**Hanging or Cabin Compass**, small size, best mounted, japanned Brass		1 10 0
771	Ditto ditto, full size ditto, ditto, bright Brass (fig. 771) .		2 12 6
772	Ditto ditto, Brass, turned arms, and best Transparent card (fig. 772) . . . . 42s.	2 10 0	3 0 0
773	Ditto ditto, Brass ditto, with **Double Dipping Needles** .	3 3 0	3 10 0
774	**Azimuth or Amplitude Compass**, plain mounting . .	3 3 0	3 10 0
775	Ditto ditto, with divided Silver ring, and Folding Sights, in polished mahogany box (fig. 775)	4 10 0	5 10 6

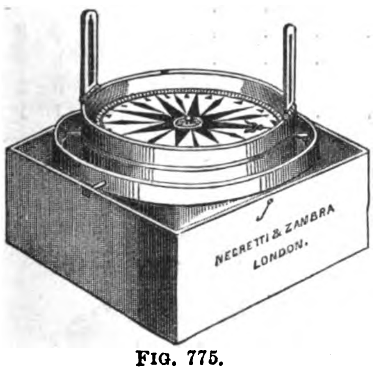


FIG. 775.

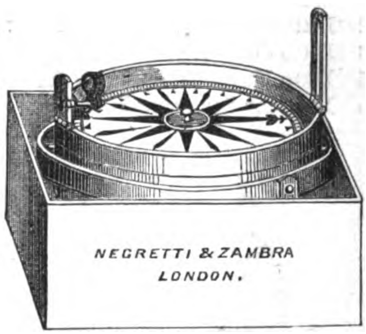


FIG. 776.

No.	Description	Each. £ s. d.	Each. £ s. d.
776	**Best Prismatic Azimuth Compass**, with Shades arranged for iron ships (fig. 776)	6 6 0	8 8 0
777	**Tripod Stands** for above . . . . . . from		1 16 0
778	**Spirit or Liquid Compass**, 6-inch best mounted for **Iron Ships**		6 6 0
779	**Prismatic Azimuth Compass**, with Copper ring, inside bowl (SNOW HARRIS's arrangement), best mounted in mahogany box, specially suited for **Iron ships** . .		8 0 0
780	**Transparent Compass** (SNOW HARRIS's), with 7½-inch Copper ring, best mounted		5 12 6

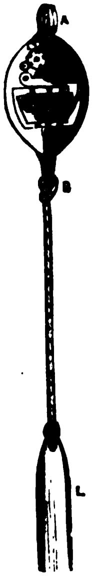


Fig. A. 4.

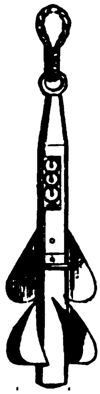


Fig. A 1.

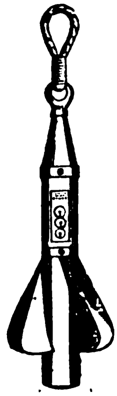


Fig. A 2.

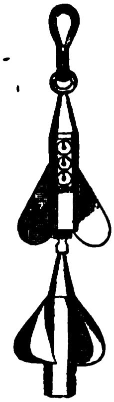


Fig. A 3.

No.	Article	Each. £	s.	d.
781	**Walker's Patent Harpoon Ship-Log** (fig. A 1.) . .	3	10	0
782	Ditto ditto (fig. A 2.)	3	3	0
783	Ditto ditto, Detached Ship-Log (fig. A 3.)	3	3	0
784	Ditto **Harpoon Sounding Machine** (fig. A 4.) without Lead	3	3	0
785	**Lead for Sounding Machine**	1	1	0

Fig. A 5.

Fig. A 6.

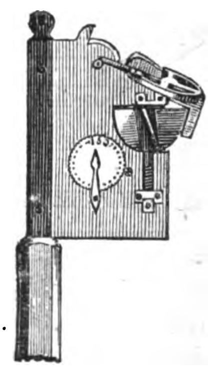


Fig. A 7.

No.	Article	£	s.	d.
786	**Massey's Patent Ship-Log** (fig. A 5.)	3	10	0
787	Ditto, Improved ditto, ditto (fig. A 6.)	2	15	0
788	**Massey's Sounding Machine** (fig. A 7.), with Lead .	4	0	0
788*	The Pendent Log supplied to order.			

LOG AND TIME GLASSES.

No.	Description	Filled with Sand. Each. £ s. d.	Filled with Metal. Each. £ s. d.
789	**Log Glasses**, in strong Wood frames, 14 seconds, per dozen		0 15 6
790	**Log Glasses**, 28 seconds, per dozen		0 15 6
	Ditto ditto, 14 and 28 seconds, best **Brass** frames		0 5 0
791	**One-minute Glasses**, in stout plain Wood frames	0 1 6	0 2 6
792	**Three-minute** ditto ditto	0 1 8	0 3 0
793	**Five-minute** ditto ditto	0 1 9	0 3 6
794	**Quarter-hour Glasses**	0 1 6	0 2 6
795	**Half-hour Glasses**	0 2 0	0 3 6
796	**One-hour** ditto	0 3 6	0 5 6
797	**Two-hour** ditto	0 4 0	0 6 0
798	**Quarter-hour Glasses**, in Rosewood or Boxwood frame		0 8 6
799	**Half-hour** ditto, ditto		0 11 6
800	**One-hour** ditto, ditto	0 12 6	0 16 0
801	**Quarter-hour Glasses** in **Brass** frames		0 10 6
802	**Half-hour Glasses** ditto		0 14 6
803	**One-hour** ditto ditto		0 18 0
804	**Tea Brokers' Sample Glasses**, plain Wood frame		0 1 6
805	**Auctioneers' One-minute Glasses**, in a turned Wood Pocket case	0 10 6	0 15 0
806	**Time Glasses**, mounted in Ivory or Fancy Wood frames and for any time. To order.		

No.	Description		£ s. d.	£ s. d.
807	**Speaking Trumpets, Japanned**		0 5 0	0 15 0
808	Ditto ditto, **Brass**	8s. 6d.	0 15 0	0 18 6
809	**Fog Horn, Brass**	5s., 6s.	0 12 6	0 14 0
810	Ditto ditto, **Japanned**	2s. 6d., 4s.	0 5 6	0 7 6
811	**Hand Fog Bells**, turned edge and crown:— 5-inch, 9s.; 6-inch, 12s.; 7-inch, 21s. each.			
812	**Key's Patent Fog Signals**, giving a louder and more prolonged blast than the fog horn, with **Brass** horns to screw on bellows		0 14 0	0 16 0
813	Ditto ditto, **Tin** ditto, fixed in ditto		0 12 0	0 14 0
814	**Ships' Chronometers**, (8 days), of the very best construction			42 0 0

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815 Admiralty and Official Charts, Maps of all parts of the World, Nautical Almanacs, Admiralty Sailing Directions, Log Books, Cargo Books, Journals, and other Nautical Publications. To order.

816 **Bunting** of all widths and qualities, Signal Flags, various Codes, in sets roped and toggled complete, in painted boxes, Royal Standards, Ensigns, Union Jacks, and all other English and Foreign Flags. To order.

Ship's Compasses and Barometers repaired and adjusted.

Telescopes, Binocular Look-out Glasses or Horizon Sweeps, Drawing Instruments, &c., &c. See sections.

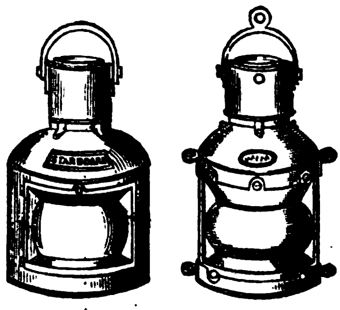

FIG. 818.

SHIPS' LIGHTS AND SIGNAL LAMPS, &c.

No. 1 *size for Vessels up to* 300 *Tons.* *No.* 2. *size above* 300 *Tons to* 500 *Tons.*
No. 3. *size* 500 *Tons to largest Vessels built.*

		SIZES. No. 1. £ s. d.	No. 2. £ s. d.	No. 3. £ s. d.
817	**Port and Starboard Lamps, Japanned** . . . per pair	1 12 6	2 2 0	2 15 0
818	Ditto ditto, **Copper** (fig. 818) . .	2 15 0	4 0 0	5 0 0
819	Ditto ditto, **best quality, Japanned** per pair	2 0 0	2 10 0	3 0 0
820	Ditto ditto, best **Copper** „	4 0 0	5 0 0	6 0 0
821	**Globular Anchor Lamps, Japanned** each	0 13 0		
822	Ditto ditto, **Copper** . . „	1 4 0		
823	**Circular Anchor, Japanned, best** each	0 18 6	1 4 0	1 10 0
824	Ditto ditto, **Copper**	2 0 0	2 12 0	3 0 0
825	**Mast Head Lamps, Japanned, best** each	1 10 0	2 10 0	3 3 0
826	Ditto ditto, **Copper** . . „	3 0 0	3 10 6	4 12 6
827	**Tricolour, Telegraph, or Steering Lamp, Japanned** . . each	1 10 6	2 2 0	2 12 0
828	Ditto ditto, **Copper** . . „	2 10 0	2 18 0	3 10 0

BOW, MAST-HEAD, AND ANCHOR LAMPS.

With **Moveable** Plano-Convex Lenses.

Constant complaints of the breakage of Lenses, and consequent loss of the use of the Lamps, through the impossibility of fitting a new Lens until the Ship arrives in port, has impelled the patentee to construct the moveable Lens, so that in the event of a Lens being broken it can at once be replaced by the removal of a few screws, and without any skill being required in the operation.

The value of this plan will be evident, when it is remembered that without either spare Lamps, or an arrangement of this kind, a Ship with a useless Lamp may at any moment find herself cast in damages from a collision, consequent on not showing the Light required by law.

The above facts show that Vessels should be provided with spare Lamps, or with the moveable spare Lenses, thereby causing a saving of sixty per cent.

The Lenses of these Lights are made in one piece, and of remarkable clearness. The tint of colour used is that which has been proved to be the most penetrating after careful experiments. No bars pass before the glass, thus avoiding any loss of light.

Spare Lenses warranted to fit, can be sent properly packed to any part of the World.

829 **Bow or Side Lamps, Masthead and Anchor Lamps,** with **Moveable** Plano-Convex **Navy** Lenses (fig. 818)

	Japanned Tin.			Copper.			Spare Moveable Lenses for Copper Lamps.			Tin Lamps.		
Size No. 1, for Vessels up to 300 tons.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Masthead (White) . each	1	14	0	2	15	6	0	17	0	0	15	6
Port (Red) . . . „	1	18	0	2	17	6	0	18	0	0	16	6
Starboard (Green) . „	1	14	0	2	10	6	0	15	6	0	14	6
Anchor, 8-in. diam. (White) „	1	14	0	2	15	0	0	13	6	0	13	6
Size No. 2 (as adopted in the **Navy**), for Vessels above 300 to 500 tons.												
Masthead (White) . each	2	10	0	3	6	0	1	1	0	1	0	0
Port (Red) . . . „	2	12	0	3	10	0	1	5	0	1	4	0
Starboard (Green) . „	2	10	0	3	8	0	1	0	0	1	0	0
Anchor, 8-in. diam. (White) „	1	14	0	2	15	0	0	14	0	0	13	6
Size No. 3, for Vessels 500 to 1000 tons.												
Masthead (White) . each	3	3	0	4	10	0	1	6	0	1	3	6
Port (Red) . . . „	3	10	0	4	11	0	1	9	0	1	5	0
Starboard (Green) . „	3	7	0	4	4	0	1	6	0	1	3	6
Anchor 8-in. diam. (White) „	1	14	0	2	14	6	0	14	0	0	14	0
Size No. 4 (as adopted in the **Navy**), for the largest Vessels built.												
Masthead (White) . each	4	10	0	5	10	6	1	14	0	1	10	0
Port (Red) . . . „	4	12	6	5	16	0	1	16	6	1	13	0
Starboard (Green) . „	4	4	0	5	12	6	1	9	6	1	8	6
Anchor, 8-in. diam. (White) „	1	14	0	2	15	0	0	13	6	0	14	0

829° **Prepared Oil,** for use in above Lamps, 7s. 6d. per gallon.

830 By virtue of the "Merchant Shipping Act Amendment Act, 1862," and of an Order in Council, dated 9th January, 1863, the following Regulations, containing certain verbal Amendments, are substituted for the Regulations contained in the Schedule to the Act.

Open Fishing Boats and other open Boats shall not be required to carry the Side Lights required for other vessels; but shall, if they do not carry such Lights, carry a Lantern having a Green Slide on the one Side and a Red Slide on the other Side; and on the Approach of or to other Vessels such Lantern shall be exhibited in sufficient time to prevent collision, so that the Green Light shall not be seen on the Port Side, nor the Red Light on the Starboard Side.

Fishing Vessels and open Boats when at Anchor, or attached to their Nets and Stationary, shall exhibit a bright White Light.

Fishing Vessels and open Boats shall, however, not be prevented from using a Flareup in addition, if considered expedient.

Steam Tugs require an additional *Mast-head Light.*

	£	s.	d.	£	s.	d.
831 **Convertible Signal Lamp** (Nunn's Patent), combining Port, Starboard, and Anchor lights, for open, fishing, and other boats, small yachts, &c., meeting all the requirements of the Government regulation for small craft with a **Single Lamp**. Japanned	1	1	0	1	7	6
Copper	2	0	0	2	12	6
832 A box containing One Gross of **Wicks** to suit above **Lamps** with trimming **Scissors**				0	10	6

When fittings are required on the Port and Starboard Lamps, it should be stated on the order. Extra charge 6s. to 9s. each.

833 **Dioptric Signal Lanterns** (Oliver's Patent), giving double the light of ordinary lamps, with the same consumption of oil.

	£	s.	d.
816 **Anchor Signal Lanterns**, Japanned, with Brass shades	1	7	6
817 Ditto ditto . Copper . . .	1	15	0
818 **Masthead Signal Lanterns**, Japanned, with Brass shades	2	10	0
819 Ditto ditto . Copper . . .	3	10	0

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834 **Binnacle, Cabin or Saloon, Engine Room, Boiler, and Forecastle Lamps Hand, Gimbal, or Hanging Lanterns,** &c., &c., of every form.

835 **Green and Ruby Glasses, Lenses and Prisms, Reflectors, Fittings for Ship Lamps,** &c., &c.

836 **Deck Glasses, Flat, Prismatic, or Round, Glass Deck Lights, Round and Square Glasses for Scuttles,** at per lb.

837 **Harbour and Pier Head Lights.** Price according to size, colour, and power of the light. Made to order.

In our Appendix will be found instructions for truly fixing or setting SUN DIALS; *also,* TABLES *of the* EQUATION OF TIME *and the Difference of Time between various localities* EAST *and* WEST *of* GREENWICH.

SHIP'S BINNACLES.

FIG. 824.

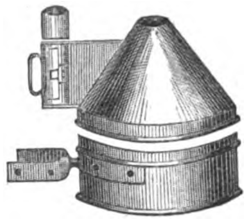


FIG. 829.

FIG. 825.

		Each. £ s. d.	Each. £ s. d.
823*	**Yacht Binnacle** all **Brass**, short Urn shape . . .		7 7 0
824	**Ships' Binnacles** (fig. 824), all bright Brass, best make, with two Lamps, bolts, and plates for deck, &c. 10-inch bowl, £12 12s.; 11-inch bowl, £13 13s.; 12-inch bowl £15 15s.		
825	**Ships' Binnacle** (fig. 825), Globe shape, Brass top, with lamps on French polished Mahogany Stand, 11-inch .	9 9 0	10 10 0
826	**Brass Binnacle Tops,** of Globe, Light-house, or Helmet form, *with two best Lamps.*		

10-inch Compass	11-inch	12-inch	13-inch	14-inch
£5	£6	£7	£8	£9

		Each. £ s. d.	Each. £ s. d.
827	**Brass Binnacle,** Urn shape, with lion's head handles, adapted for yachts and steamers, on octagon polished Mahogany stand, with two lamps in shade for a 10-inch compass		12 12 0
828	**Brass Dolphin Pattern Binnacles,** and other ornamental patterns . . . . £12 12s.	15 15 0	16 16 0
829	**Masthead Binnacles,** with band for Mast and one Lamp (fig. 829)		5 5 0

The Compasses are not included in any of the above prices.

Extra cost for Compass 18s. to 38s. each.

The true Magnetic Westerly Variation of the Compass (1878) for London is 19° 20′ at Kew, 18° 52′ Greenwich. The Annual decrease, 8′. The daily Oscillation 10′.

Maximum Easterly Variation yet recorded was observed by Burroughs in 1580, viz., 11° 17′.

Maximum Westerly Variation observed by Colonel Beaufoy in 1815, 24° 27′ 18″.

Years of no Variation, 1657 to 1662.

"As regards the *Direction* of the Wind, it is hardly necessary to observe that this should **always** be given according to *True and* NOT *to Compass bearings.* The amount of Variation of the Compass in the British Islands being, roughly speaking, two points to the westward, we get the following table for the conversion of directions observed by compass in the United Kingdom to approximate true bearings."

Compass Bearings.	N.	N. N. E.	N. E.	E. N. E.	E.	E. S. E.	S. E.	S. S. E.
True Bearings.	N. N. W.	N.	N. N. E.	N. E	E. N. E.	E.	E. S. E.	S. E.
Compass Bearings.	S.	S. S. W.	S. W.	W. S. W.	W.	W. N. W.	N. W.	N. N. W.
True Bearings.	S. S. E.	S.	S. S. W.	S. W.	W. S. W.	W.	W. N. W.	N. W.

ROBERT H. SCOTT, ESQ.

The late Admiral FitzRoy in his *Weather Book*, writing on this subject in connection with Meteorology, remarks :—

"Some observers notice smoke, others clouds (seldom going with the *local* wind *below*, though generally correct as respects the *prevailing* wind), some mark the vane or weather-cock, while only a few of the lighthouse and telegraph observers know how their points of reference bear by the world (or map) or by a magnetic needle, of which the variation is still less often known within a point of the compass (if indeed understood). Such persons should be advised to *mark* a true East and West line, *about the time of the Equinox*, March 20th and September 23rd, by the Sun at Rising or Setting; and by it give their bearings, or directions of wind. And they should take the Wind's direction from that of the *lower* clouds (when they are not very distant), compared with that of vanes and smoke,—in preference to any other indication."

Table of the height in feet of the rise of SPRING TIDES *in various parts of the World.*

	Ft.		Ft.		Ft.		Ft.
Abbey Head, England	23	Corunna, Spain	15	Heligoland	9½	Ramsgate	15
Aberdeen, Scotland	12	Charlestown, U.S.	6	Hong Kong	4½	Rio Janeiro	4
Adelaide, Australia	6	Dover	18½	JerseyChannelIslands	30½	Ryde Bay	22
Aden Bay, Arabia	7	Dungeness	21½	St. John, Bay of Fundy	27	Sheerness	16
Agnes Pt., Scilly Isles	16	Dieppe	27	Lowestoft	6½	Swansea, Mumbles Lt.	27
Air Point, R.D., Eng.	25	Demerara, Guiana	9	Lundy Island, Bristol Channel	27	St. Malo	25
Akyab, Bay of Bengal	9	Eddystone Light	18	Margate	15½	San Francisco	4½
Algoa Bay, Africa	6½	Fleetwood	26½	Malaga, Spain	3	Sierra Leone	8
Beachy Head	20	Flatholm Islands	37	Melbourne, Australia	8	Sarawak, Borneo	16½
BridgewaterBar, Eng.	35	Folkestone	20	Maulmain, Bengal	22	Singapore	10
Bergen, Norway	4	Foreland, N.	10	Needles Point	7½	Shanghai	10
Bombay	12·17	Foreland S.	18	New York, U.S.	5	Sydney	4½
Boulogne	25	Formby Point	28	Nelson, N.Z.	14	Trinidad	4
Boston, U.S.	11½	Gravesend, Thames	1[illegible]	Philadelphia, U.S	6½	Table Bay	5
Caermarthen, Wales.	26	St. Katherine Dock	24	Port Philip, Australia	4	Woolwich	18½
Chatham	17½	Caribbee Islands	1½	Port Royal, Jamaica	1	Yokohama	6½
Cape Clear, Ireland	9	Harwich	11½			Zanzibar	10
Calais	19½	Hastings	24				

MATHEMATICAL DRAWING INSTRUMENTS.

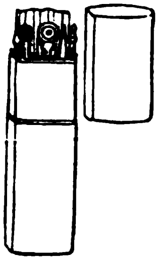


FIG. 831.

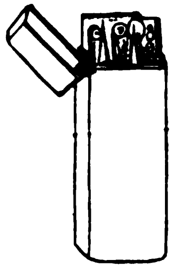


FIG. 833.

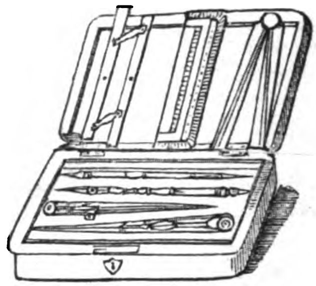


FIG. 834.

SETS OF DRAWING INSTRUMENTS, IN CASES.

FOR ELEMENTARY DRAWING, &c., IN SCHOOLS, &c.

No.	Description	Each. £ s. d.	Each. £ s. d.
830	**Small or Half-Set of Steel-jointed Drawing Instruments,** consisting of compasses, with pen and pencil points, feeder and boxwood scale; in pull off case .		0 5 6
831	**Steel-jointed Drawing Instruments,** consisting of large compasses, pen and pencil points, plain divider, feeder and box scale; in pull off case (fig. 831)	0 7 6	0 10 6
832	**Steel-jointed Drawing Instruments,** consisting of dividers, compasses with pen and pencil points, ruling pen, bow pen, feeder, ebony parallel rule, box sector, and protractor; in hinged fish-skin case . . .	0 15 0	0 18 0
833	**Best turned cheek Steel-jointed Drawing Instruments,** consisting of fine dividers, compasses with slip, pen and pencil points, ruling and bow pens, feeder, best ebony parallel rule, boxwood sector and scale; in fish-skin or leather hinged cases (fig. 833)	1 5 0	1 15 0

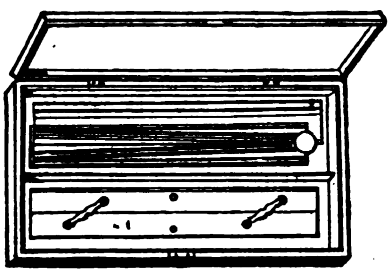


FIG. 834.

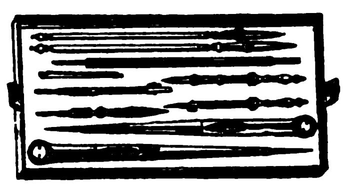


FIG. 834*.

No.	Description	Each. £ s. d.	Each. £ s. d.
834	**Sets of French or Swiss Drawing Instruments,** in convenient flat mahogany and rosewood boxes, adapted to Elementary or School purposes (figs. 834 and 834*). 3s. 6d., 5s. 6d., 8s. 6d., 10s 6d.,	1 5 0	1 10 0

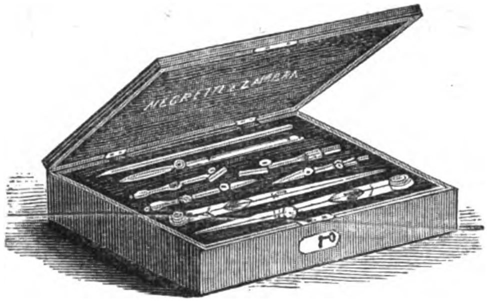


FIG. 838.

DRAWING INSTRUMENTS, IN CASES,

OF SUPERIOR FINISH, FOR THE USE OF ARCHITECTS, ARTISTS, ENGINEERS, &C.

No.	Description	Each. £ s. d.	Each. £ s. d.
835	**Set of Drawing Instruments,** consisting of sector-jointed compasses, with pen and pencil points, dividers, drawing pen, bow pen, feeder, pencil, boxwood sector and protractor, and ebony parallel rule; in mahogany case . Brass		1 15 0
836	**Set of Drawing Instruments,** consisting of sector-jointed compasses, with pen and pencil points, dividers, bow pen, drawing pen, lengthening bar, feeder and pencil, Boxwood protractor and sector, and ebony parallel rule; in mahogany case . . . . . Brass		2 2 0
837	**Set of Drawing Instruments,** similar to No. 836, with ivory scales and rule; in mahogany or rosewood case		2 10 0
838	**Set of Drawing Instruments,** similar to No. 837, with bow pen and bow pencil, lengthening bar, Ivory rule and scales; in mahogany or rosewood case (fig. 838) .	2 12	3 3 0

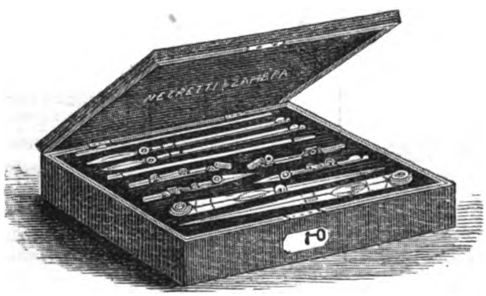


FIG. 839.

No.	Description	Each. £ s. d.	Each. £ s. d.
839	**Set of Drawing Instruments,** similar to No. 838, with fine hair dividers, Ivory scales and rule; in rosewood case (fig. 839)		4 4 0

No.		Each. £ s. d.	Each. £ s. d.
840	**Set of Best Sector-jointed Mathematical Drawing Instruments**, consisting of compasses with extra joint, pen and pencil point, fine hair dividers, bow pencil and bow pen with extra joints, lengthening bar, two drawing pens, needle holder, feeder and pencil, full divided Ivory protractor and sector, and Ivory parallel rule; in rosewood or mahogany case . . . Brass		5 10 0
841	**Set of Best Sector-jointed Mathematical Drawing Instruments**, similar to No. 840, with jointed lengthening bar, and dotting pen with wheels; in metal clamped mahogany or rosewood case with spring, bow pen, pencil and dividers (fig. 841) . . . . . Brass		6 6 0
842	**Set of Mathematical Drawing Instruments**, similar to No. 841, with proportional compasses		7 7 0

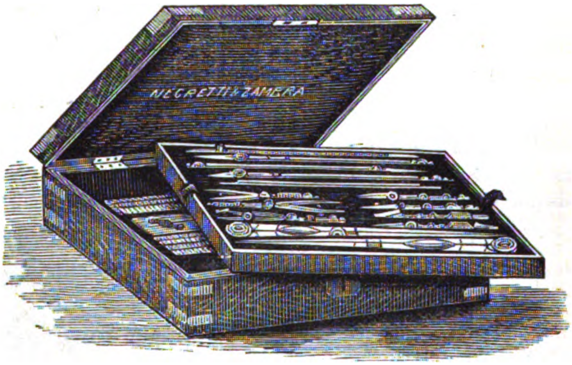


FIG. 841.

843 **Sets of GERMAN SILVER Mathematical Drawing Instruments,**

Similar to Nos.	836.	837.	838.	839.	840.	841.	842.
	£2 14s.;	£3 3s.;	£3 12s.;	£4 15s.;	£6 6s.;	£7 7s.;	£8 8s.

German Silver is recommended as best adapted for warm, damp climates, where the moisture soon injures and destroys the ordinary Brass Instruments.

No.		Each. £ s. d.	Each. £ s. d.
844	**Pocket Set of Brass Drawing Instruments**, consisting of compasses, pen and pencil points, drawing pen and Ivory scale; in wood or leather case . . £1 10s.	2 10 0	3 3 0
845	**Pocket Set of German Silver Drawing Instruments**, consisting of fine hair dividers, and lengthening bar, with pen and pencil points, bow pen, bow pencil, drawing pen, and Ivory scale; in wood or leather cases	2 10 0	3 10 0

These Pocket Sets can be fitted up and varied to order.

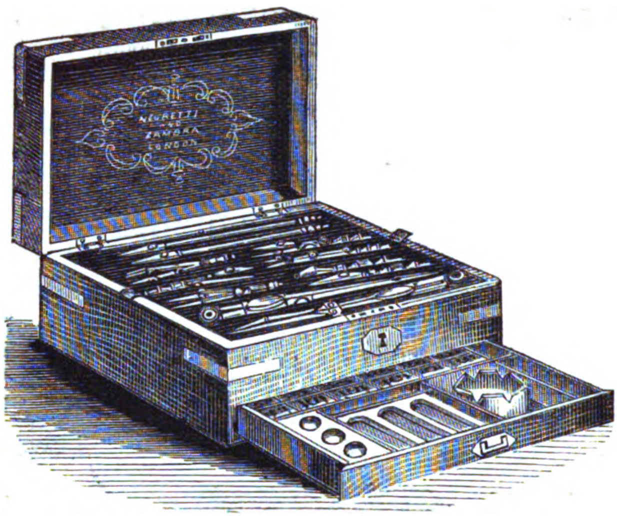


FIG. 846.

		Each. £ s. d.	Each. £ s. d.
846	**Magazine Case of Mathematical Drawing Instruments,** German Silver, as No. 846, with extra road and wheel pen, a set of **Colours** with Brushes, Palettes, and Saucers in handsome brass clamped box (fig. 846) . . .		12 12 0

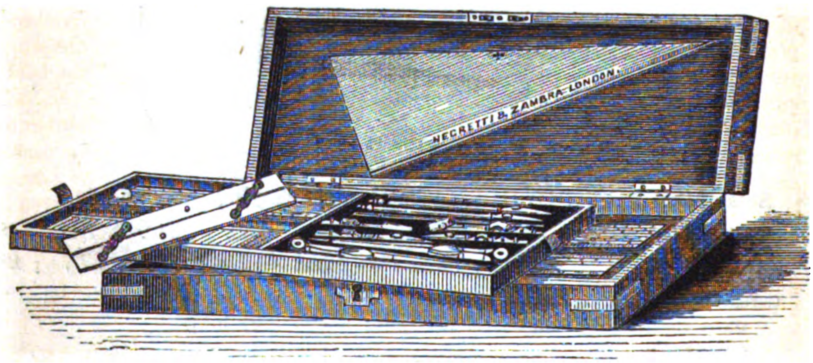


FIG. 848.

847	**Addiscombe Cadets' Set of Mathematical Drawing Instruments,** consisting of best sector-jointed compasses, pen and pencil points, fine hair dividers, bow pen and pencil, lengthening bar, drawing pen, feeder and pencil, Ivory red-line protractor, sector and parallel rule, boxwood marquoise scales, and angle; in mahogany case with lock and key, Brass . . .		3 10 0
848	Ditto ditto in German Silver, and with Ivory Scales and Rules (fig. 848)		4 10 0

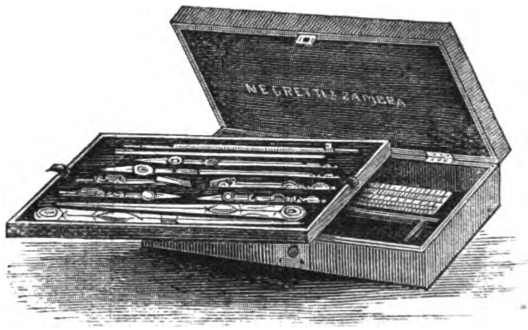


FIG. 851.

No.	Item	Each. £ s. d.	Each. £ s. d.
849	**Set of Mathematical Drawing Instruments,** as used at the Royal Military College, Woolwich		3 3 0
850	**Set of Mathematical Drawing Instruments,** as used at King's College and College of Civil Engineers . .	2 15 0	3 10 0
851	**Ordnance Pattern Set of Drawing Instruments,** compasses, pen and pencil points, lengthening bar, dividers, bow pen and bow pencil, large and small drawing pens, turn-screw, six drawing pins, Ivory scales, and ebony parallel rule; in mahogany case with snap fastening (fig. 851)	2 10 0	3 3 0

852 **Magazine Case of Mathematical and Engineering Drawing Instruments,** of our very best manufacture, in German silver, or Electro or Nickel-plated. These sets contain proportional compasses, beam compasses, various sizes of drawing, road, and wheel pens, dividers, a set of the best spring bows, bow pen and bow pencil, complete sets of architects' scales, plotting or chain scales and off-set scales, curves and angles, plain and rolling parallel rules, circular and semi-circular protractor, drawing pins, sets of the very best water colours, brushes, palettes and saucers, &c.; conveniently arranged in brass-bound polished Mahogany, Oak, or Rosewood cabinet, superior lock and key, with trays and drawer

Price, £15 15 0, £22 0 0, and £25 0 0

Sets of Mathematical Drawing instruments in **Solid Silver** made to order.

DIVIDERS, COMPASSES, DRAWING PENS, SPRING BOW PENS, ETC.

No.	Item		£ s. d.	£ s. d.
853	**Dividers, Brass-jointed,** 5 and 6-inch .	from per doz.		0 11 0
854	**Dividers, Steel-jointed**	each. 1s. 6d.	0 2 6	0 3 0
855	**Five and Six-inch best Brass Sector-joint Dividers** .		0 4 6	0 5 6
856	Ditto ditto, German silver	(fig. 856)	0 5 6	0 7 6
857	**Five and Six-inch Hair Dividers, Brass**		0 7 6	0 10 6
858	Ditto ditto ditto, **German Silver** .	(fig. 858)	0 8 6	0 12 6
859	**Pocket Dividers,** with sheath			0 10 0
860	**Double-jointed Dividers,** with **Needle Points, German Silver**			1 18 0

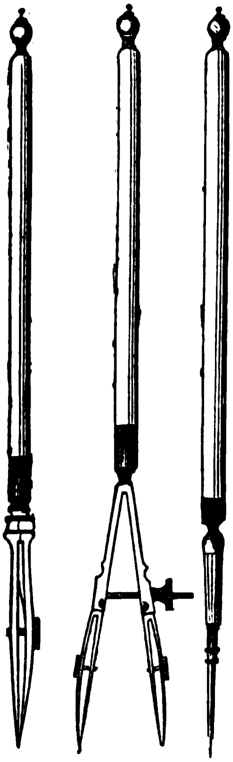


FIG. 878. FIG. 882. FIG. 884.

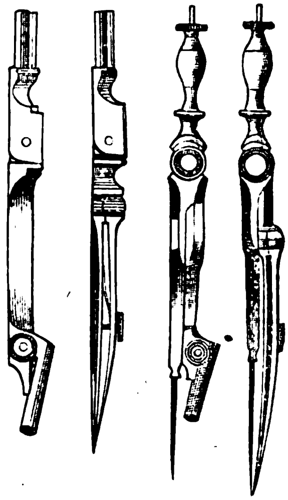


FIG. 860†. FIG. 865.

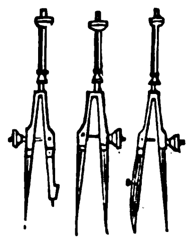


FIG. B. C. A.

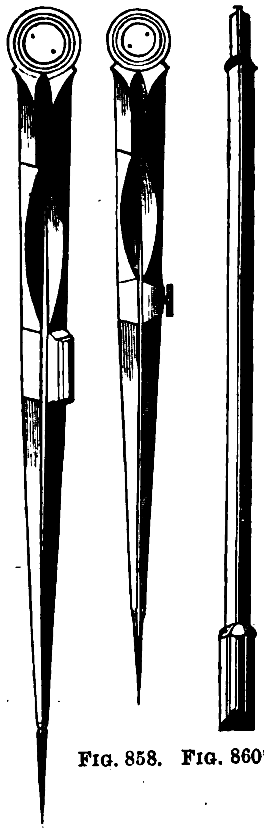


FIG. 858. FIG. 860*.

FIG. 856.

		Each.			Each.		
		£	s.	d.	£	s.	d.
860*	**Compasses or Dividers,** best brass, 6-inch, with pen and pencil joint, and lengthening bar				0	12	6
860†	Ditto ditto German silver, best (figs. 856, 860*, 860†)				0	15	6
861	**Pocket Turn-in Dividers,** brass . . (fig. .)				0	10	6
862	Ditto ditto ditto, German silver				0	13	0
863	**Spring Dividers,** all Steel, with Adjusting screw . .	0	7	6	0	10	6
864	**Bow Pens, or Bow Pencils,** common				0	3	6
865	Ditto ditto, best (fig. 865)				0	5	6
866	Ditto ditto . . . . . with **Extra Joints** .				0	8	6
867	**Steel Spring Bow Pens** (fig. A)	0	5	0	0	7	6
868	Ditto ditto **Pencils** (fig. B)	0	5	0	0	7	6
869	Ditto ditto **Dividers** (fig. C)	0	5	0	0	7	6
870	Ditto ditto best **Swiss** . . . . . . each				0	10	6
871	**Set of Best Spring Bow Dividers,** Pen and Pencil, in Pocket Case	1	10	0	1	10	6
872	Ditto ditto for **Needle Points** (fig. 872) . . .				1	15	0
873	**Double-pointed Bow Pen,** with Turn-over pen, pencil, and point, in case				0	18	0

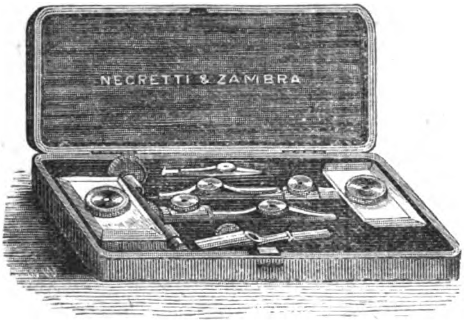


FIG. 902.

FIG. 872.

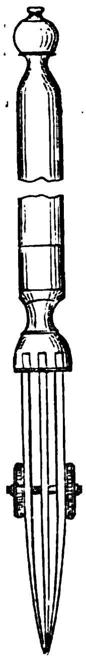


FIG. 879.

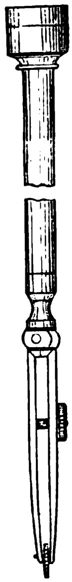


FIG. 880.

No.		Each. £	s.	d.	Each. £	s.	d.
874	**Plain Drawing Pen,** with brass handle and protracting pin (fig. 874*) . . . . . from				0	2	6
875	Ditto ditto, **all Steel** . .				0	3	6
876	**Drawing Pens,** with Ivory handle (fig. *)	0	3	6	0	4	6
877	Ditto ditto, with lift Brass joints to the blades, and Ivory handle .				0	5	6
878	**Drawing Pens,** best German Silver lift joints and spring (fig. 878) .	0	5	6	0	7	6
879	**Drawing Pens,** for very thick lines (fig. 879)				0	10	6
880	**Dotting Pen,** with Ivory handles and Wheels (fig. 880) . . .	0	10	6	0	16	0
881	**Road Pen**				0	12	6
882	**Road Pens,** Best Make (fig. 882) .				0	16	0
883	**Needle Holder,** or Pricking Point				0	4	6
884	Ditto ditto, best improved (fig. 884)				0	6	6
885	**Map Meter or Opisometer,** for measuring Curved lines on plans or charts (fig.) see page .	0	3	6	0	4	6
886	**Triangular Compasses,** Brass .	0	12	6	1	5	0
887	Ditto ditto, German silver, with shifting leg	0	16	0	1	10	0
888	**Elliptical Compasses** or Trammel	2	10	0	4	4	0

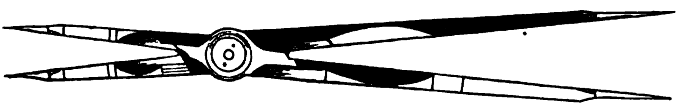


FIG. 899.

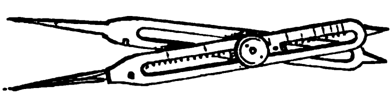


FIG. 890.

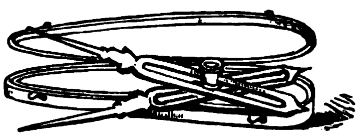


FIG. 891.

No.		£	s.	d.	£	s.	d.
889	**Proportional Compasses,** common Brass . . .				1	1	0
890	Ditto ditto, with Rackwork Adjustment (fig. 890) . .				1	10	0
891	Ditto ditto, full divided German Silver (fig. 891)	2	2	0	2	10	0

FIG. 893.

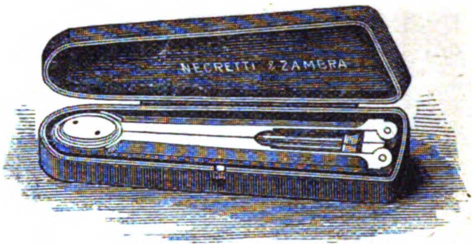


FIG. 894.

		Each. £	s.	d.	Each. £	s.	d.
892	**Proportional Compasses**, full divided, best make, . .						
	Tangent Screw, Screw Adjustment				3	3	0
893	**Pocket Divider**, with turn-in points (fig. 893) . . .	0	13	0	0	16	0
894	**Napier's Pocket Compasses**, with Revolving pen and pencil points, in neat hinged case (fig. 894) .	2	2	0	2	10	0

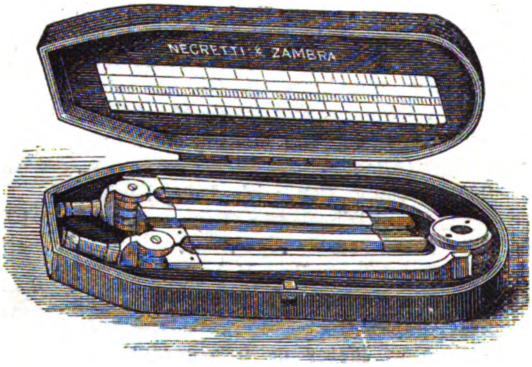


FIG. 898.

		£	s.	d.	£	s.	d.
895	**Pillar Compasses**, in Brass	1	5	0	1	10	0
896	Ditto ditto, in German Silver, in neat case	1	18	0	2	2	0
897	Ditto ditto, with Lengthening Bars, in case				2	5	0
898	Ditto ditto . . with Ivory scale, in ditto (fig. 898)				2	12	6

The Pillar Compasses form a most convenient pocket set of Drawing Instruments for travellers, comprising a large pair of dividers, with pen and pencil joint, also a bow pen and bow pencil. Nos. 897 and 898 have *lengthening bars*, by which *very large* circles and curves may be drawn either in ink or pencil.

		£	s.	d.	£	s.	d.
899	**Whole and Half Compasses** (fig. 899)	0	18	0	1	5	0
900	**Tube Beam Compasses**				2	15	0
901	**Beam-Compass fittings**, plain for any bar	1	6	0	1	10	0
902	Best ditto ditto, with **Tangent** Screw and steel points (fig. 902) in case	1	15	6	2	5	0
903	**Tube Compasses**, with case and scale				2	2	0
904	Ditto ditto . . . best Sector-jointed, in case				2	12	6
905	**Callipers, Proportional**, 12-inch	2	2	0	2	12	6
906	Ditto ditto . . . 9-inch	1	16	0	2	2	0

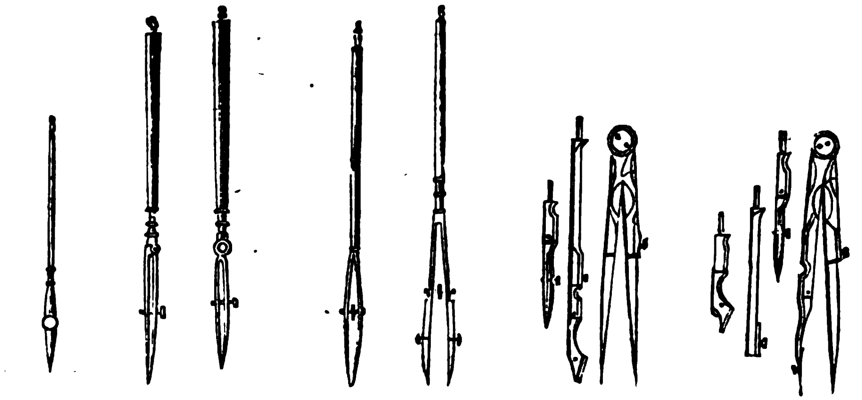


FIG. 910. FIG. 910.* FIG. 911. FIG. 907. FIG. 908.

No.	Small sets of Drawing Instruments, *without Boxes.*	Each. £	s.	d.	Each. £	s.	d.
907	No. 1. Compasses with pen and pencil joint and lengthening bar (fig. 907) . . . . . per set				0	2	6
908	No. 2. Ditto ditto, with drawing pen (fig. 908) per set				0	3	6
909	No. 3. Ditto ditto *Steel jointed* superior finish .	0	4	5	0	6	6
910	Common Ruling pens (figs. 910 and 910*) . Each	0	1	6	0	2	6
911	Ditto ditto, for *Double lines* (fig. 911) . . .				0	5	6

SCALES, RULES, &c.

FIG. 912.

912 **Parallel Rules, Ebony,** Plain Brass Bars :—(fig. 912)

	6-in.	9-in.	12-in.	15-in.	18-in.	24-in.
912	1s.	2s.	3s.	3s. 6d.	4s. 6d.	7s. 6d.
913 Ditto ditto, **Ebony Brass Edged**			10s. 6d.	12s. 6d.	15s. 6d.	18s. 6d.

		£	s.	d.	£	s.	d.
914	**Parallel Rule, Ivory,** 6-inch Brass mounts	0	3	0	0	4	0
915	Ditto ditto, *best* German Silver mounts	0	5	0	0	7	6

FIG. 916.

916 **Parallel Rules, Rolling, Ebony** Plain :—

6-in.	9-in.	12-in.	15-in.	18-in.
6s. 6d.	8s.	10s. 6d.	14s.	16s.

917 **Rolling Parallel Rules, with Plain Ivory Edges and Rollers :—**

6-in.	9-inch.	12-in.	15-in.	18-in.
9s.	11s.	15s.	18s.	21s.

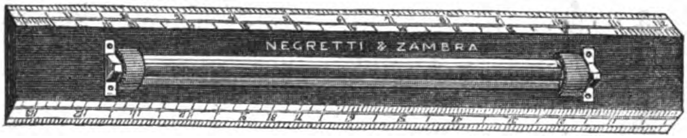


FIG. 918.

No.	Description	Each. £ s. d.	Each. £ s. d.
918	**Rolling Parallel Rules**, best, with full divided **Ivory Edges** and rollers, German Silver mounted :—(fig. 918) 6-in. 13s. 9-in. 18s. 12-in. 24s. 15-in. 28s. 18-in. 38s.		
919	**Rolling Parallel Rule and Protractors**, all **Ivory** and German Silver mounted (best), **Full Divided** 15-inch		3 3 0
920	**Parallel Rules, brass**, best :— 6-in. 8s. 12-in. 14s. 18-in. 26s. 24-in. 42s.		
921	**Parallel Rules, Rolling Brass**, best :— 6-in. 16s. 12-in. 28s. 18-in. 56s. 24-in. 84s.		
922	**Architects' Scales, 12-inch Boxwood**		0 3 6
923	**Ditto ditto 12-inch Boxwood,** full divided . .		0 6 0
924	**Ivory Architects' Scales, 12-inch** (fig. 924) . . .		0 12 6
925	Ditto ditto **6-inch,**		0 6 6
926	**Ivory Architects' Scales, 12-inch** *best,* Full Divided, from ⅛ to 3-inches, containing 16 scales		0 18 0
927	**Six-inch** ditto ditto		0 10 6

FIG. 924.

No.	Description	Each. £ s. d.	Each. £ s. d.
928	**Chain or Plotting Scales, best Ivory, 12-inch** 80 to 100		1 1 0
929	**Off-sets** for ditto . **Best Ivory**, 2-inch . . .		0 6 0
930	**Chain or Plotting Scales, best Ivory, 12-inch,** 10 to 60 chains to the inch (fig. 630)		0 12 6
931	**Six-inch** ditto ditto best Ivory		0 6 6
932	**Off-set Scales, Ivory,** 10 to 60 . . . . from		0 3 6
933	**Chain or Plotting Scales, best Boxwood, 12-inch,** 10 to 60		0 3 0
934	Ditto ditto, **12-inch Best Boxwood,** ditto 80 to 100 . .		0 6 0
935	Ditto ditto, **6-inch Boxwood** ditto		0 3 0
936	**Off-sets, Boxwood,** 10 to 60		0 1 6
937	**Off-sets, Boxwood,** 80 to 100		0 2 0
938	Complete sets of **best Ivory Plotting Scales and off-sets,** 12-inch, from 10 to 100 chains to the inch, in mahogany case, with lock and key		6 6 0
939	Complete sets of **best Boxwood Plotting Scales,** 12-inch with off-sets, 10 to 100 chains, in mahogany box . .		2 5 0
940	**Six-inch Ivory Parallel Rules,** German Silver Mounts	0 5 6	0 7 6

No.	Article	Each. £ s. d.	Each. £ s. d.
941	**Six-inch Ivory Sector Scales**	0 6 0	0 8 6
942	**Six-inch Ivory Protractors**	0 5 0	0 7 0
943	**Ditto best full-divided Ivory ditto**		0 8 6
944	**Twelve-inch Ivory Protractors,** full divided		1 15 0
945	**Red-line Protractor,** best for Military drawing		0 6 6
946	Ditto ditto, **Ivory** . . . . best, with scale of feet		0 8 6
947	**Six-inch Boxwood ditto Sectors**		0 3 0
948	**Six-inch Boxwood Protractors**	0 1 0	0 3 6
949	**Six-inch Ivory best Navigation Scales,** full divided		0 10 6
950	**Six-inch Military best Ivory Scales**		0 8 6
951	**One-foot Gunter's Scales, Boxwood**		0 4 6
952	**Two-feet** ditto ditto		0 5 6
953	**Two-feet Sliding Gunter's Scales** (Donn's)	0 10 6	0 16 0
954	**Marquois Scales, Boxwood,** in case complete		0 14 6
955	Ditto ditto, without case		0 12 6
956	Ditto ditto Ivory		3 3 0
957	Ditto ditto Metal		4 4 0
958	**Gunner's Rules**		0 10 6
959	**Negretti and Zambra's 2-foot 4-fold Ivory Pocket Rule,** combining the Protractor, Sector, and a 2-foot rule, best, full divided in leather case		3 10 0

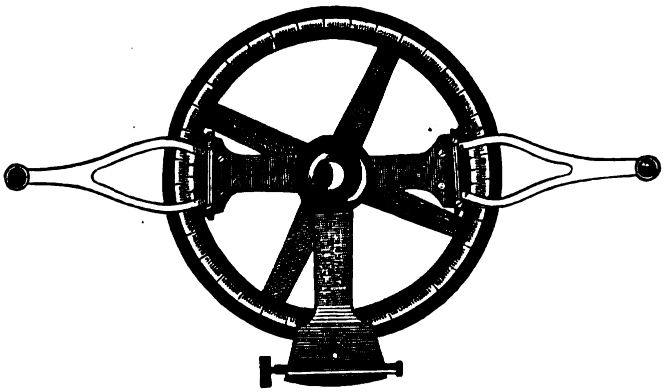


FIG. 967.

960 **Protractors, in Horn,** semi-circular, transparent, very convenient for roughly measuring angles on paper, &c. :—

Divided into degrees—	3-in.	$3\frac{1}{2}$-in.	4-in.	5-in.	6-in.
	6d.	8d.	10d.	1s. 6d.	2s.

No.	Article	£ s. d.	£ s. d.
961	**Card Protractors**		0 3 0
962	**Brass Protractors,** plain Semi-Circular	0 1 6	0 5 6
963	**Brass Semicircle Protractors,** plain, divided to ten minutes	1 2 0	1 10 0
964	**Brass Semicircle Protractors,** 6-inch, with Arm and Vernier, transparent centre (see figs. 679 and 680) page 205		3 3 0

No.	Article	Each. £ s. d.
965	**Brass Circular Protractors**, plain— 6-in. 23s. 9-in. 35s. 12-in. 42s.	
966	**Circular Protractors**, Brass, 6-inch, with Tangent screw adjustment and clamp to Vernier, in mahogany box .	4 16 6
967	Ditto ditto best 6-inch divided on Silver, with Folding Arms (fig. 967)	6 0 0
968	Ditto ditto . 7-inch, £7, 8-inch ditto . . .	8 0 0

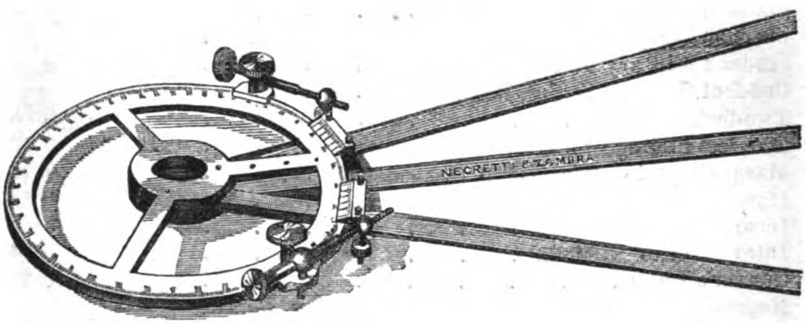


FIG. 970.

No.	Article	Each. £ s. d.
969	**Station Pointers for Hydrographical Surveys**, 6-inch plain, divided on Brass, with 12-inch arms . . .	7 15 0
970	Best ditto 6-inch, with Silver divided Circles and Verniers, Tangent Screw adjustments (as fig. 970), with arms lengthening to 18 inches, in mahogany case	11 0 0
971	7-inch ditto ditto, arms lengthening to 24 inches .	13 0 0
972	8-inch ditto ditto, ... to 30 inches .	15 15 0

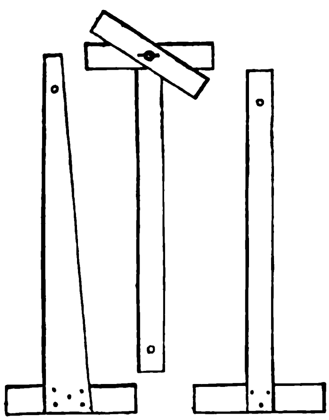
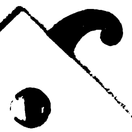


FIG. 973*. FIG. 974. FIG. 973.

No.	Article	Each. £ s. d.
973	**T or Drawing Squares, Lancewood or Mahogany**:—	
	12-inch plain (fig. 973) 2s. 6d., with bevel (fig. 973*)	0 4 0
	18-inch „ . . . 3s. 6d., „	0 5 0
	24-inch „ . . . 4s. 6d., „	0 6 0
	36-inch „	0 7 6



. A.

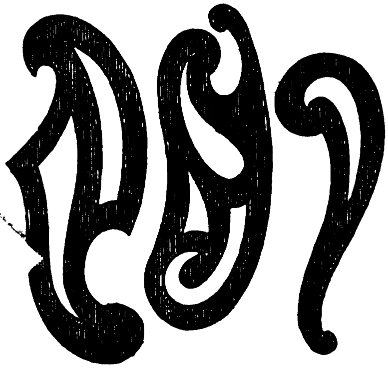


FIG. 983 B.

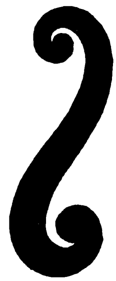


FIG. 983 C.

No.	Article	Each. £ s. d.	Each. £ s. d.
974	**T Squares, Mahogany,** with shifting bevel and clamp, best (fig. 974):— 18-in. 5s. 6d.; 24-in. 7s.; 30-in. 8s.; 36-in. 9s.		
975	**T Squares, Ebony,** plain:— 18-in. 7s.; 24-in. 9s.; 36-in. 12s. 6d.		
976	**T Squares, Ebony,** with shifting bevel and clamp:— 18-in. 8s. 6d.; 24-in. 10s.; 36-in. 14s.		
977	**Steel, T Squares,** per inch		0 0 8
978	**Steel Triangles,** various		
979	**Steel Straight Edges,** stout best, per foot		0 4 6
980	Ditto ditto flexible, per foot		0 3 0

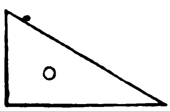
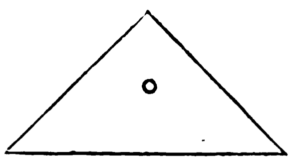


FIG. 981.



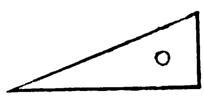


FIG. 981.

No.	Article	Each. £ s. d.	Each. £ s. d.
981	**Ivory, Ebony, and Boxwood Acute, Obtuse, and Right Angles, or Set Squares,** various (figs. 981) . from 1s.,	0 2 0	0 7 6
982	**Mathematical Curves, or Scrolls,** Pear tree, set of 12		0 12 6
983	**Architectural Curves,** 30 different (figs. 983) . 1s. .	0 2 0	0 3 6
984	**Ship Curves** (fig. 984) . . . . 1s. 6d.	0 1 9	0 2 0
985	**Set of Radii Curves** (fig. 985)	1 1 0	5 0 0
986	**Set of 25 Regular Curves,** from 1½ to 30 inches . .		0 10 6

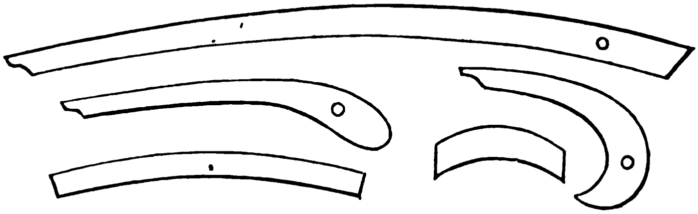


FIG. 984. FIG. 985.

No.	Article		Each. £ s. d.	Each. £ s. d.
987	**Set of 50 Regular Curves**, in case from $1\frac{1}{2}$ to 100 inches			1 10 0
988	**Ebonite Scales, Rules, Set Squares, Curves, Slopes, and Batters for Railway Embankments**, &c., at a slight advance on the price of Boxwood. Ebonite cannot be much recommended.			
989	**Mitford's Double Set of Ivory Pocket Scales**, arranged for Engineers, Architects, &c. The length of each scale, six inches; the form of a single scale a right-angled triangle, two making a square or set; the two sets are packed in a leather case, and the ends of each scale stamped with its value. The triangular form enables all the scales to be conveniently placed on the edges. The scales are seventeen in number fully divided, viz., 2, 3, 4, 6, 8, and 10 chains to the inch; 66 feet and 6 inches to the mile; $\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{10}$, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$-inch, and French metre; the Ordnance scale and a line of chords; a number of constants carefully worked out, are placed on the faces of each scale. Price for complete set, in case . . .			£3 3 0
990	**Horn Centre Pieces**	per doz.		0 3 0
991	**Drawing Pins**, Brass	„ 1s.	0 1 6	0 2 0
992	Ditto ditto, extra large Brass	„		0 4 0
993	Ditto ditto, **German Silver**	„ 2s.	0 3 0	0 4 0
994	Ditto ditto, extra large German Silver . .	„		0 5 6
995	**Drawing Pencils**, all kinds and colours. To order.			
996	**Small Pencils for Mathematical Instruments** . . .		0 0 4	0 0 6
997	**Crayon Holders**	from		0 1 6
998	**Drawing Boards**	7s. 6d.	0 10 6	1 1 0
998*	**Black Board Compasses**, Wood and Metal . . .		0 10 6	0 12 6
999	**Tracing Paper**	per sheet, 3d., 4d.	0 0 6	0 1 0
1000	**Ditto Cloth**	per yard	variable.	
1001	**Pen Machines** for making or mending Quill Pens .		0 12 6	0 15 0
1001°	**Cutting Compasses of Steel, with Screw adjustment** and three knives, for cutting Circles of Cardboard to 4-inches diameter			1 4 0
1002	**Paper Weights** for holding drawings or papers flat on a table. Circular			0 2 0
1003	Ditto ditto, Oblong, leather covered			0 3 0
1004	**Brass Clamps** to fasten straight edge to drawing board .			0 4 0
1004*	**Erasing and Pen Knives**	1s. 6d.	0 6 0	0 7 6
1004†	**Lamps with Shades** for drawing Table or Board, either for Gas, Oil, or Paraffin		1 6 0	2 10 0

Engraving name on case of Drawing Instruments with date, 2s. 6d. to 5s.; Crests or Monograms, 5s. to 10s. 6d.; Presentation Inscriptions varying according to the Length and Style of engraving, ornamentation, &c.

FIG. 1008.

PREPARED WATER COLOURS BY THE MOST APPROVED MAKERS.

		Each. £	s.	d.	Each. £	s.	d.
1004*	**Mahogany Slide Lid Boxes,** Half Cakes . 7s. 6d.	0	10	6	0	15	0
1004†	Ditto Ditto Whole Cakes	0	12	6	1	1	0
1005	**Twelve-cake Water Colour Box,** mahogany, with lock and key				1	1	0
1006	**Twelve-Cake,** ditto ditto, with drawer containing saucers, brushes, pencils, &c.	1	5	0	1	10	0
1007	**Twelve-Cake Water Colour Box,** caddy lid, mahogany, with drawer containing inkstone, palettes, cut water glass, extra brushes, pencils, &c.	2	2	0	3	3	0
1008	**Twelve-Cake** ditto ditto, handsome Spanish mahogany, brass clamped, and with superior fittings, (fig. 1008) .	4	4	0	5	5	0
1009	**12, 18, and 24-Cake Water Colour Boxes,** rosewood, brass or German silver bound, very handsome £6 6s.	10	10	0	25	0	0

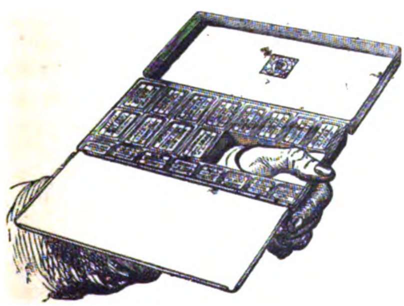


FIG. 1009*.

1009* **Moist Water Colours in Japanned Tin Box,** with selected list of Improved Moist Colours for Photographic Portraiture, &c., Best Sable and Camel Hair Brushes &c. (as fig. 1009*) £1 1s.; £1 10s.; £2 2s.

Any special Colours supplied to order.

1009† **Lock Mahogany Box,** with velvet Palette, Brushes, Stumps, Shells, &c., with 24 Colours for colouring or Tinting Photographs, £2 2s.

GAUGING RULES AND INSTRUMENTS FOR DISTILLERS, MALTSTERS, OR WINE AND SPIRIT MERCHANTS, &c.

1010 **Gauging Instruments,** as used by the Board of Customs, a Complete Set, consisting of long calliper, cross calliper, bung rod, with brass slider, 4-feet, and head rod, with book of instructions for use, adapted for spirit or oil-gauging.
Price £4 4 0

1101 **Gauging Rods,** straight, with line of inches and tenths, diagonal line. Dips for every sized spirit and beer casks.

Lancewood	4 ft.	5 ft.	6 ft.
	6s. 6d.	8s. 6d.	9s. 6d.

1012 **Dipping Wine and Spirit Rules,** with similar scales and divisions as above.

	s.	d.		s.	d.
3 feet, 4 fold	6	6	5 feet, 8 fold	12	0
3 „ 6 „	8	6	6 „ 6 „	12	0
4 „ 4 „	7	6	6 „ 8 „	14	0
4 „ 6 „	9	6	6 „ 12 „	22	0
5 „ 6 „	10	6			

No.	Article	Each. £	s.	d.
1013	**Double Diagonal Rods,** imperial and old measure, with table of Outs of Casks.			
1014	**Double Diagonal 5-feet Gauging Rod,** with table	0	8	6
1015	Ditto, ditto 4 ditto ditto	0	6	6
1016	**Spile Rods,** Boxwood, screw jointed. For gauging the dip of a cask through the spile hole.			
	6-feet spile rod, screw joints	0	14	6
	5-feet ditto ditto	0	12	6
	4-feet ditto ditto	0	10	6
	3-feet ditto ditto	0	8	6
1017	**Spile Rod,** without joints	0	3	6
1018	**Proof or Temperature Slide Rules,** 6-inch, boxwood, for use with Sikes' hydrometer	0	4	6

1019 **Comparative or Reducing Slide Rule,** showing the number of gallons of water required to reduce spirits from a high to a low strength, &c., &c., as supplied with Sikes' Hydrometer, 6-inch boxwood . 0 4 0

1020 **Sliding Rule,** for correcting the indications of the Hydrometer, when the temperature of the spirit is either above or below 55 degrees of Fahrenheit. The rule is composed of two parts, the long scale being divided similar to the Hydrometer, ranging from 45 under to 70 over proof. The small moving scale representing temperature from 30 to 80 degrees Fahrenheit. This Rule is used as follows. Having placed the Hydrometer in the spirit to be tested and noted, the reading on the scale—say, for example, 20 over proof: take the temperature—say it is 70. Now move the sliding scale until the star is directly opposite 20 O.P. on the long scale, and opposite the 70 of the temperature scales will be found 15 over proof, which is the strength of the spirit. Price 4s. 6d.

1021 **Ullage Rules,** Plain, for use with dip rod or rules.

12-in.	18-in.	24-in.	36-in.
7s.	10s. 6d.	14s. 6d.	18s. 6d.

1022 **Gauging, Ullaging, Reducing and Valuing Rule,** with two slides . . . .
In conjunction with a dip rod, this rule will gauge the contents of any cask, and give the value of spirits.

9-in.	12-in.	18-in.	24-in.
10s. 6d.	12s. 6d.	14s. 6d.	18s. 6d.

1023 Book of Instructions for using Nos. 1021 and 1022, 2s.

1024 **Float Rod or Bung Gauge,** plain mounted, 3 to 20 feet.

3 ft.	4 ft.	5 ft.	10 ft.
7s. 6d.	10s. 6d.	13s. 6d.	26s.

1025 Ditto ditto, 100 inches, with improved Joint, 45s.

1026 **Oil Rods,** round steel, divided into inches, tenths, and diagonals, 3 feet, 25s.; 6 feet, 30s.

1027 **Screw Sticks,** 9-inch joint. See Spile Rods, No. 1016.

1028 **Malt Rods or Sticks,** round wood, divided into inches, tenths, and diagonals.

30-in.	36-in.	48-in.	60-in.
5s. 6d.	6s. 6d.	7s. 6d.	8s. 6d.

1029 **Malt Rods or Sticks,** Round Brass, per foot, 6s. 6d.

1030 Ditto ditto flat ditto 5s. 6d.

1031 **Malt Receivers,** for sampling malt from a bin or sack, 4s. 6d., 7s. 6d., and 10s. 6d.

1032 **Malthouse Steel Cistern Rod,** strong Brass mountings, showing to 50 inches £0 15 6

1033 **Malt House Couch Rod** 0 7 6

1034 **Gauging Tape Measure,** or Malt Tapes.

400-in.	500-in.	600-in.
8s. 6d.	10s. 6d.	12s. 6d.

1035 **Verie's or Veroe's Malt Gauging or Ullaging Rule, Two Slide** . . . . 9-inch, 8s. 6d.; 12 inch, 10s.

Ivory Gauging Rules to order.

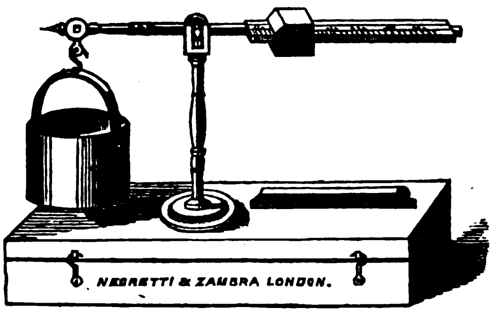


FIG. 1036.

1036 **Chondrometer, or Corn Balance,** for ascertaining the differential value of Corn, Barley, Malt, Seeds, &c.; in mahogany box, with instructions for use, and Table of average weights of grain and seeds (fig. 1036):—

	Each. £	s.	d.
⅛th of a pint	2	2	0
¼ "	2	12	6
½ "	3	3	0

ENGINEERS' AND CARPENTERS' POCKET RULES, TIMBER AND ROPE GAUGES, &c.

No.	Description	Each. £	s.	d.	Each. £	s.	d.
1037	**Carpenters' Rules,** Boxwood, 2 feet, 2-fold	0	2	6	0	3	6
1038	Ditto ditto best Boxwood, 2 feet, 4-fold and joint	0	4	6	0	8	6
1039	**Pocket Rules,** Boxwood, 1 foot folding	0	2	6	0	5	6
1040	Ditto ditto Boxwood, 2-feet, best, full divided . .	0	12	6	0	10	6
1041	**Pocket Rules,** Ivory, 1-foot folding, German silver mounts	0	8	6	0	12	6
1042	Ditto ditto full divided	0	16	0	1	5	0
1043	Ditto ditto 2-feet folding, ditto ditto 16s.	1	5	0	1	10	0
1044	**Pocket Rules,** Ivory, four-fold full divided, in case .	2	2	0	2	10	0
1045	Ditto ditto **French Metre**; divided to Decimetres, Centimetres, and Millimetres; on the reverse side the English yard—inches and 1-8ths, and on the edge French inches and lines, 4-fold, best Boxwood . .	0	16	0	0	18	6
1046	**Improved Engineers' Rule,** in Boxwood, with book of instructions	0	12	6	1	1	0
1047	Ditto ditto, in Ivory	2	2	0	2	10	0
1048	**Ivory Pocket Rule, 12-inch four-fold,** with English, French, Spanish, and Rhineland scales . . .				0	10	6
1049	**Hull Callipers,** for Square timber measuring, 12-inch				1	10	0
1050	**Bow** ditto Round ditto 10-inch				0	18	6
	Larger sizes of these Callipers at about 1s. 6d. to 2s. per inch, according to size.						
1051	**Timber, Plank and Cubing Rules, Measuring Rods,** and Tapes marked with inches and quarter girt . .	various prices.					
1052	**Scribing Iron**	0	3	6	0	5	6
1053	**Rope Gauge,** Boxwood and Brass				0	8	6
1054	Ditto ditto German Silver and Ivory . . .				0	15	6
1055	**Rule or Gauge for Measuring Horses,** to close up in the form of a walking stick				1	1	0
1056	**Cattle Gauge,** with Tape Measure, giving solid contents				0	8	6

1056* **Radii Curves** cut to order in Vulcanite, Brass, or German Silver, any radius up to 100 feet.

Tem-plates of Rails made in Metal *to order*.

GLOBES AND ORRERIES.


FIG. 1057.


FIG. 1058.

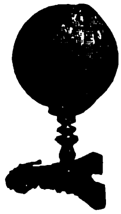


FIG. 1058*.

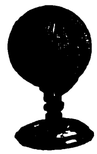


FIG. 1058*.


FIG. 1059

1057 **Pocket Globes,** 3-inch diameter, in hinged case (fig. 1057) . . . . 10s. 6d to 16s.

1058 **Pedestal Globes,** mahogany base, with semi-circular brass meridian and quadrant of altitude (figs. 1058 and 1058*) :—

Diameter	9-in.	6-in.	4½-in.	3-in.
Each .	21s. 24s.	9s. 10s. 6d.	6s. 7s.	4s. 5s.

1059 **Table Globes,** black stained wood frames, with brass meridian and quadrant of altitude (fig. 1059)

Diameter	15-in.	12-in.	9-in.
Per Pair	£6 6s.	£4 4s.	£3 3s.

1060 **Table Globes,** mahogany frame, with brass meridian and quadrant of altitude (fig. 1059):—

Diameter	20-in.	15-in.	12-in.	9-in.	6-in.
Per Pair .	£10 10s.	£6 18s.	£4 15s.	£3 12s.	£2 4s.


FIG. 1061.

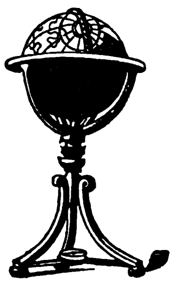


FIG. 1061*.

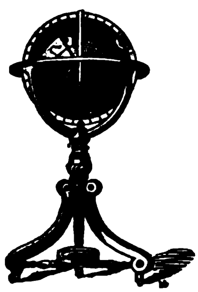


FIG. 1062.


FIG. 1063.

1061 **Globes mounted Chair high, best Plain mounted** pillar and claw, with compasses and quadrant of altitude (fig. 1061):—

Diameter	25-in.	20-in.	15-in.	12-in.
Per Pair .	£25	£14	£9 9s.	£6 6s.

1062 **Globes mounted Chair high, Superior Carved** and polished pillar and claw frames, **with Compasses,** quadrant of altitude, and double hour circles (fig. 1062):—

Diameter	25-in.	20-in.	15-in.	12-in.
Per Pair .	£31 10s.	£16	£11	£7 10s.

1063 **Globes mounted Chair high,** on highly finished and carved tripod frames, of polished Spanish mahogany, with Compasses, quadrant of altitude, and double hour circle, with all recent improvements (fig. 1063):—

Diameter	25-in.	20-in.	15-in.	12-in.
Per Pair .	£36 15s.	£18 18s.	£13.	£8 10s.

1064 **School Globes,** mounted to Suspend from the ceiling, with quadrant of altitude (fig. 1064):—

Diameter	25-in.	20-in.	15-in.	12-in.
Each .	£7 7s.	£3 10s.	£2 2s.	£1 5s.

1065 **Globes** mounted in rosewood, walnut-wood, satin-wood, &c., at 10 to 20 per cent. increase on the above prices. Any particular style of frame made to order.

1066 **Covers for Globes** of leather cloth for high frames:—

For 25-inch Globe	20-inch Globe.	15-inch Globe.	12-inch Globe.
42s.	32s.	22s.	14s.

1067 **Brass Quadrants of Altitude:—**

For 25-in. Globe.	20-in. Globe.	15-in. Globe.	12-in. Globe.	9-in. Globe.	6-in Globe.
11s.	7s.	5s.	4s. 6d.	3s. 6d.	2s. 6d.

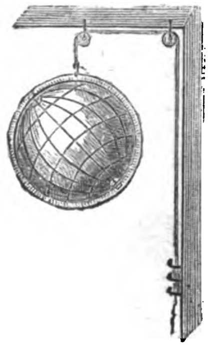


FIG. 1064.

Old Globes repaired and re-covered with modern maps, and the brass mountings cleaned and re-lacquered, rendering them equal to new.

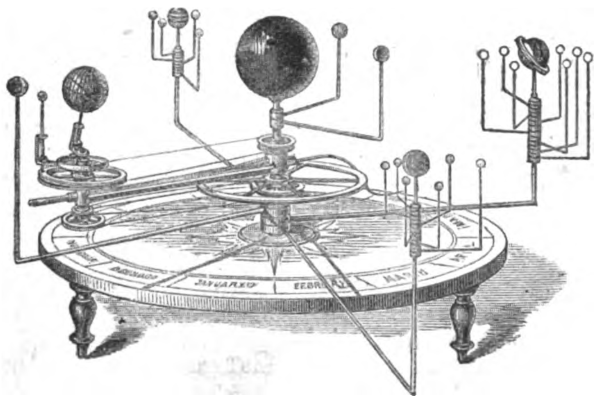


FIG. 1069.

		Each. £ s. d.	Each. £ s. d.
1068	**Manual Planitariums, or Tellurians,** showing the relative positions of the planets and their satellites, &c.	3 3 0	5 5 0
1069	**Orrery,*** with plain mounting, to move by the hand	5 5 0	6 6 0
1070	**Orrery,** exhibiting the relative positions of all the principal planets and their satellites; the diurnal and annual motion of the earth; the moon's phases and nodes, &c.; to move with a train of wheel work and winch handles (fig. 1069)	10 10 0	16 16 0

1071 **Complete Orreries,** representing the motions of all the planets and their satellites; the various movements of the earth and moon; the sun rotating on its axis, &c.; arranged with very superior clock-work motion, in a mahogany and brass frame . . . . from 50 0 0

1072 **Diagrams, illustrating the Sciences of Astronomy, Geography, Geology, &c., &c.,** for class teaching, or suited to lectures, supplied to order.

* The Orrery was invented and first constructed by Mr. John Rowley, for King George the First; afterwards a second machine was ordered by the Earl of Orrery, and named by its inventor after his Patron. Archimedes is said to have made something of a similar nature to imitate the movements of the planets and stars.

OPTICAL INSTRUMENTS.

The science of Optics, which consists in the examination of the phenomena of light and vision, is one of the most important and most useful branches of physical science. By the aid of its appliances we are permitted to obtain a glimpse of the immensity of the universe, and are enabled to reveal wonders of creation, of which but for this power granted to us we should be in perfect ignorance. By means of the Telescope we are made acquainted with the existence of spheres and worlds floating in boundless space, illustrating in the most sublime manner the perfect harmony that exists in the motions of the heavenly bodies.

The Microscope affords an insight into the minute structure of animal and vegetable life, and discloses to the wondering spectator forms of life, the variety and beauty of which display in the most convincing manner the infinite powers of the Great Creator.

But of all the gifts which science has so freely lavished on humanity, and all tending to its benefit and improvement, perhaps there is none that can rank higher than the means afforded of assisting the natural vision, and of enabling us to correct in a most simple and perfect manner the irregularities of sight, which are consequent on alterations silently going on in the structure of that wonderful and delicately constructed organ, the Eye.

The sight has in all time been justly accounted the greatest of blessings, and it deserves our strictest attention in order that the advantages of it may not be lost to us at an earlier period than is absolutely necessary from physical decay.

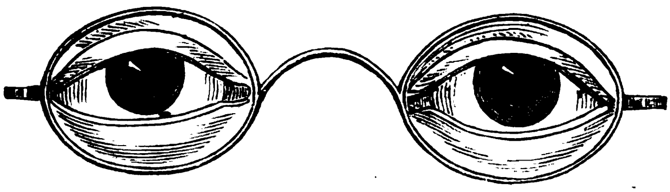
Those persons who begin to require the aid of Spectacles are obliged, before distinct vision can be obtained, to hold the candle or to have the source of light between the eye and the book they read, in order to force their pupils into a proper state of contraction, that they may see distinctly the characters before them. Now this is a state of things that should never occur, for if indulged in, and the eye be tampered with, it will eventually lead to great impairment of vision.

The power of adjustment varies exceedingly in different individuals and also at different periods in the life of each person; being strongest in youth, and gradually diminishing with advancing years.

From this circumstance it is easy to see the reason of the fatigue caused by the strain on the ciliary process of the eye in bringing it to a proper adjustment for objects at different distances, and an individual who has habitually to make an effort to adjust his eye to these variations of circumstances, should lose no time in applying to the Optician to obtain assistance from the use of glasses.

From what we have said above, let it not be supposed that the indiscriminate use of Spectacles is recommended; very far from it. We must, before resorting to Spectacles, ascertain the nature of the defect in the visual organs, and then have the amount, and only the exact amount of correction applied: just in the same manner as with a telescope, we are obliged to draw out the eye-tube until a perfect image appears in the field of view, nothing more nor less will suffice to this end.

SPECTACLES.



READING AND EYE GLASSES, EYE PRESERVERS, ETC., TO SUIT ALL AGES AND SIGHTS, GLAZED WITH THE FINEST BRAZILIAN PEBBLES OR BEST OPTICAL FLINT GLASS.

The greatest care taken that the Pebble, or Glass Lenses, are correctly worked and polished, as well as carefully tested and suited to the sight of the Purchasers, and also that the Frames are formed to fit the face.

		Each. £ s. d.	Each. £ s. d.
1073	**Common Spectacles,** in Horn, Iron, or German Silver mountings . . . . . . from 2s., 2s. 6d.	0 3 0	0 4 6
1074	**Best Tortoise-shell ditto** with Brazil Pebbles . .		1 1 0
1075	Ditto ditto, with Glasses		0 15 0

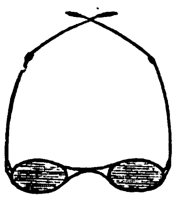


FIG. 1089.

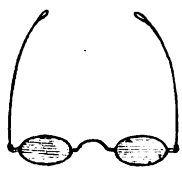


FIG. 1076.

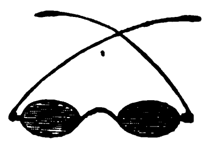


FIG. 1076*.

1076	**Blue Steel Spectacles,** with single or turn-over sides, suited for ladies or gentlemen, a strong serviceable article, with best quality **Convex** lenses, for aged or Long sight (figs. 1076 and 1076*) . . . . 5s.	0 6 0	0 7 6
1077	**Blue Steel Spectacles,** with best **Concave** lenses for Short or near sight . . . . 5s. 6d.	0 7 0	0 8 0
1078	**Best Elastic Blue or Bronzed Steel Spectacles,** very light and strong, for ladies or gentlemen, best lenses to suit any sight	0 10 6	0 12 6
1079	Ditto ditto, with finest **Brazil Pebbles** . . .	0 15 0	0 18 6

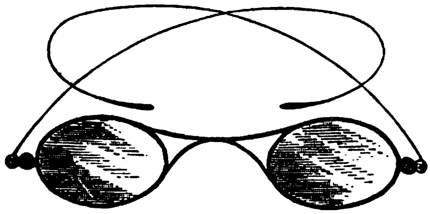


FIG. 1082.

		Each. £ s. d.	Each. £ s. d.
1080	**Perlivision or Invisible Spectacles of Blue or Bronzed Steel,** in which the lenses are **Grooved** to receive the frame, that is, made so **extremely light,** as to be scarcely visible; these spectacles are especially adapted for the **Concave Lenses** worn by short-sighted persons, mounted with best Lenses . .	0 12 6	0 15 0
1081	Ditto ditto, finest Pebbles	0 18 0	1 2 0
1082	**Invisible Spectacles, Bronzed or Blue Steel,** curled sides as fig. 1082, for hunting or shooting, mounted with Grooved Lenses		0 12 6
1083	Ditto ditto in Steel with Brazil Pebbles . .		1 5 0
1084	**Gold Spectacles,** for ladies or gentlemen, with best lenses to suit any sight . . . . . 22s., 30s.	1 15 0	2 2 0
1085	**Finest Gold Spectacles,** for ladies or gentlemen, with best Brazil Pebbles, to suit any sight . . . 42s.	3 3 0	4 4 0
1086	**Finest Gold Invisible Spectacles,** nearly as light and elastic as steel, with best lenses, for any sight . .	2 2 0	2 10 0
1086*	Ditto ditto, best Brazil Pebbles	2 10 0	3 0 0
1087	**Silver Spectacles** of Standard quality, for ladies or gentlemen, with best lenses for any sight	0 12 0	0 16 0
1088	Ditto ditto, best Brazil Pebbles	0 18 0	1 5 0
1089	**French Pattern Spectacles,** in Gold (fig. 1089) . . .	1 15 0	3 3 0
	Ditto ditto, Blue or Bronzed Steel	0 10 6	0 12 6

Gold and Silver Spectacles are strongly recommended to persons residing in Tropical Climates, or at the Sea Side, as they resist the action of the moist atmosphere, which rapidly destroys Steel frames.

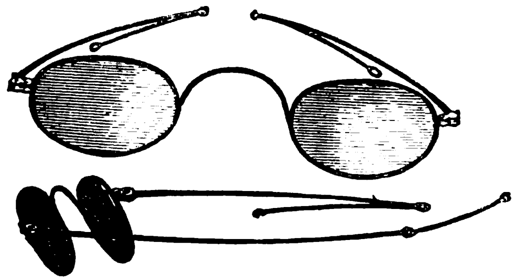


FIG. 1090.

FIG 1090*.

1090 **Patent Pantoscopic Spectacles (Forsenic Spectacles), adapted for a failing or aged sight** (fig. 1090):—

1090* The peculiar form and arrangement of these Pantoscopic Spectacles (see fig. 1090*), enables the wearer to read or work with comfort, and at the same time distant objects can be seen without the frame being removed or pushed inconveniently low down upon the face.

		Each. £ s. d.	Each. £ s. d.
1091	**Patent Pantoscopic Spectacles,** in light blue steel, for ladies or gentlemen, with the best Periscopic Lenses		0 10 6
1092	Ditto ditto, with best Brazil Pebbles	0 15 6	1 1 0
1093	Ditto ditto, in solid Gold, with best Brazil Pebbles 42s.	2 10 0	3 3 0
1094	Ditto ditto, in solid Silver, with ditto .	1 1 0	1 10 0

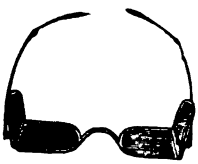


FIG. 1097.

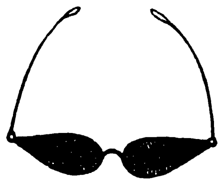


FIG. 1095.

FIG. 1095*.

1095	**Wire Gauze Eye Protectors or Dust Spectacles,** with elastic sides and nose or bridge, for railroad travelling, or preserving the eyes from dust (figs. 1095 and 1095*) 3s. 6d., 4s. 6d.	0 5 6	0 7 6
1096	**Eye Protectors,** best mounted, the edges being bound round with velvet, with neutral tint or smoke coloured glasses, of the best quality, particularly adapted for the use of travellers by the Overland Route, or in India, Australia, &c.	0 12 6	0 15 6
1097	**Best Double-jointed Horse-shoe formed Spectacles,** and turn-down sides, with green, blue, grey, neutral tint, or white glasses (fig. 1097) . . . . . 8s.	0 12 6	1 5 0
1098	Ditto ditto single-jointed . . . . 7s. 6d.	0 10 6	1 1 0
1099	**Eye Protectors,** best make, with fine wire gauze, or Glasses, either Flat or Cup or Dished-shaped eyes 15s.	1 1 0	1 10 0

No.	Description		Each. £	s.	d.	Each. £	s.	d.
1100	**Spectacles,** with single or turn-over joints, of the ordinary oval shape, mounted in blue or bronzed Steel, with neutral tint, grey or smoke-coloured glasses, for protecting the eyes from excessive glare of Sunshine, Snow, &c., or the unpleasant effects of strong Gas light	4s.; 5s. 6d.	0	6	6	0	10	6

Any of the above **Eye Protectors,** Gilt or Plated to prevent rust, at a slight advance on above prices.

No.	Description		£	s.	d.	£	s.	d.
1101	**Cataract Spectacles,** in various mountings .	10s. 6d.	0	15	0	1	1	0

Cataract Spectacles are mostly made specially to meet the requirements of the Patient.

1102 **Spectacles,** with Periscopic, Mensicus, or Neutral Tinted lenses, various forms, made to order.

FIG. 1103.

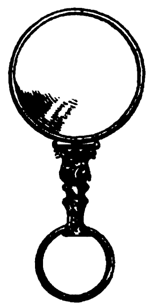


FIG. 1123.

HAND AND CLIP-NOSE SPECTACLES.

No.	Description			£	s.	d.	£	s.	d.
1103	**Folding Hand Spectacles or Folders,** for wear round the neck (fig. 1103), solid fine Gold, various patterns		63s.	3	10	0	4	10	0
1104	Ditto ditto	Plated and Electro-gilt .	21s.	1	10	0	2	2	0
1105	Ditto ditto	Solid Standard Silver . . .		1	10	0	2	2	0
1106	Ditto ditto	blue Steel, various forms .	7s. 6d.	0	10	6	0	15	0

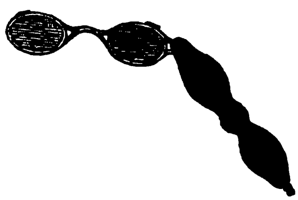


FIG. 1107.

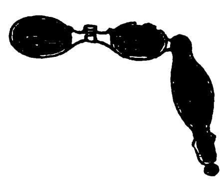


FIG. 1107*.

No.	Description	£	s.	d.	£	s.	d.
1107	**Fine Gold Hand Spectacles,** mounted in Pearl Cases, (figs. 1107 and 1107*)	3	3	0	6	6	0
1108	**Fine Gold Hand Spectacles,** in Tortoise-shell Cases .	2	10	0	5	5	0
1109	**Solid Silver Hand Spectacles,** in Pearl Cases . .	1	10	0	2	2	0
1110	Ditto ditto in **Tortoise-Shell** ditto . . .	1	1	0	2	0	0
1111	**Solid Tortoise-Shell Hand Folders,** with finest Brazil Pebbles	0	18	0	1	1	0




No. 1112.

FIG. A. FIG. B. FIG. C. FIG. D.

1112 **Solid Fine Gold Folding Hand Spectacles,** with Spring joints, and elegant mountings of various patterns, richly Engraved and Chased, or Enamelled and Inlaid, **Suitable for Presentation,** in hinged morocco leather cases (figs. A, B, C, D) . . . . price £6 6s., £8 8s. £10 10 0 £12 12 0

1113 **Tortoise-shell Hand Folders,** best glasses . 5s. 6d. 0 7 6 0 10 6

1114 **Buffalo Horn ditto** in various shapes 0 2 6 0 4 6

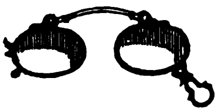


FIG. 1115.

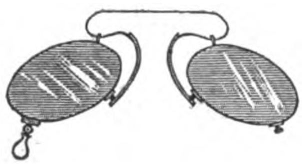


FIG. 1116†.

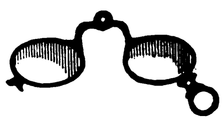


FIG. 1115*.

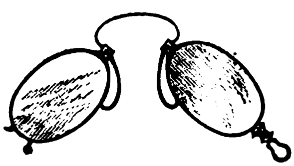


FIG. 1116.

FIG. 1116*.

1115 **Clip-Nose Spring Folding Spectacles (Pince-Nez),** to suspend round the neck, very convenient for occasional use, oval or round shapes, with variously contrived springs to suit different forms of face (figs. 1115, 1115*).

No.	Description		Each. £	s.	d.	Each. £	s.	d.
1116	Figs. 1116, 1116*, and 1116† show recent improvements in **Clip-Nose Spectacles.** The cushions, or Placquets, on the inner edges distribute the pressure over a large surface, causing the Folder to fit exceedingly firm on the face, and parallel to the eyes. These forms of Folders, known as Chinese, Japanese, or American Extension, are found to be the most comfortable in wear yet introduced.							
1117	**Clip-Nose Solid Gold Spring Folding Spectacles,**	42s.	2	10	0	3	3	0
1118	Ditto ditto . . . . . **Solid Silver** .		1	10	0	2	2	0
1119	Ditto ditto . . . . . **Gold Plated** .		1	5	0	1	10	0
1120	Ditto ditto . **Tortoise-shell, with Solid Gold Bridge**		1	10	0	2	2	0
1121	Ditto ditto ditto, with **Blue or Bronzed Steel Bridges**	10s. 6d.	0	12	6	0	18	0
1122	Ditto ditto **Blue or Bronzed Steel**		0	7	6	0	12	6

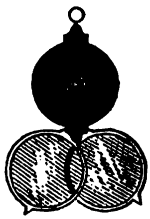


FIG. 1154.

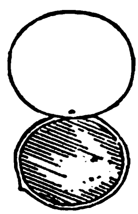


FIG. 1134.

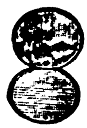


FIG. 1135.


FIG. 1136.

EYE GLASSES.

No.	Description		£	s.	d.	£	s.	d.
1123	**Fine Solid Gold Single Eye Glasses** (fig. 1123), various patterns	30s.	2	2	0	3	3	0
1124	**Solid Standard Silver** ditto		0	8	6	1	1	0
1125	**Best Plated and Electro-gilt Eye Glasses** of various forms	8s. 9d.	0	10	6	0	16	0


FIG 1131.


FIG. 1127.

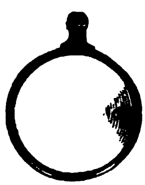


FIG. 1129.


FIG. 1126.

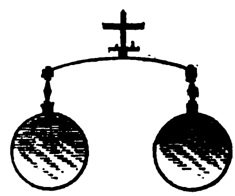


FIG. 1132.

No.	Description		£	s.	d.	£	s.	d.
1126	**Eye Glasses,** in blue or bronzed Steel frame (fig. 1126)		0	2	6	0	5	0
1127	**Eye Glasses,** without frame, drilled and edged (fig. 1127)					0	2	0
1128	Ditto ditto ditto, Periscopic					0	2	6
1129	**Eye Glasses,** Tortoise-shell (fig. 1129) . .	2s. 6d.	0	4	6	0	5	6
1130	Ditto ditto, buffalo Horn		0	1	6	0	2	6
1131	**Shooting Glasses,** Steel mounted, with screws and joints for attaching to the hat or cap, for near sights (fig. 1131)		0	10	6	0	12	6
1132	Ditto ditto ditto double sights (fig. 1132) .		1	5	0	1	10	0

No.	Article	Each.			Each.		
		£	s.	d.	£	s.	d.
1133	**Spectacle Cases,** in various mountings . . . . 6d.	0	1	0	0	5	0
1134	**Oval and Round Reading Glasses,** in Horn cases (fig. 1134) . . . . 2s. 6d.	0	5	0	0	7	6
1135	Ditto ditto Tortoise-shell case (fig. 1135) . .	1	10	0	2	2	0
1136	Ditto ditto in Pearl, with Silver mountings (fig. 1136).	1	1	0	2	2	0

Fig. 1139.

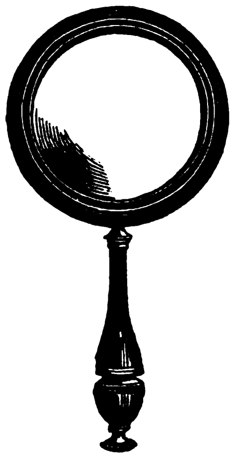


Fig. 1138.

Fig. 1141.

No.	Article	£	s.	d.	£	s.	d.
1137	**Cylindrical Lenses,** in oblong Horn, Vulcanite, or Metal, Frames 15s. 6d.; 17s. 6d.	1	1	0	1	5	0
1138	**Print Lenses,** of various sizes, in turned Wood frames, for viewing large Maps, Engravings, Photographs, &c. (fig. 1138) . . . . 15s., 21s.	1	11	0	2	2	0
1139	**Magnifying Lenses,** mounted in German Silver, with Wood Handles, suited for examining Photographs, Engravings, &c. (fig. 1139) 2s. 6d., 3s., 3s. 6d., 4s. 6d., 5s. 6d., 7s. 6d., 8s. 6d., 10s. 6d.	0	12	6	0	14	0
1140	Ditto ditto with Ivory Handles and Gilt mountings 5s. 6d., 6s. 6d., 8s. 6d., 10s. 6d., 12s. 6d., 15s. 6d.	1	0	0	1	5	0
1141	Ditto ditto mounted in buffalo Horn or Ebonite (fig. 1141) 3s. 6d., 4s. 6d., 5s. 6d., 6s. 6d., 7s. 6d., 10s. 6d., 12s. 6d.	0	14	6	0	16	6

Spectacles made to order of any shape or material, and fitted with lenses worked to any particular form. Spectacles of all forms repaired with the utmost care and despatch. Pebbles re-worked and altered to suit the variation of sight.

"Spectacles, when to Wear and how to Use them:" addressed to those who value their sight. By C. A. Long. Published by Negretti and Zambra.
Price (post-free), 6d.

NEGRETTI & ZAMBRA'S
NEW THERMOSCOPIC SPECTACLES,
FOR THE RELIEF OF WEAK, DIM, AND IMPERFECT VISION.

Enabling the wearer to read or work with comfort by gas or candle-light.

These Spectacles are the result of a series of experiments, undertaken with the view to the manufacture of a glass that should possess the power of arresting the heat that proceeds from gas-light and other sources of artificial illumination.

This desirable end having been attained by Messrs. NEGRETTI AND ZAMBRA, they are enabled to supply Spectacles, the glasses of which possess this peculiarity; that is to say, that the great heating power of gas and other artificial light is rendered perfectly inert as far as regards vision, and the amount of light that enters the eye nearly equal to that which would do so through ordinary glasses; by this means the unsightly dark glasses are superseded, and greater comfort is secured while reading or working by gas-light; at the same time the sight is preserved from the pernicious effects of the heat, and the eyes are kept as cool as when reading by ordinary daylight. The Thermoscopic Spectacles will be found, therefore, to recommend themselves to those whose avocations require great application to the desk, more especially during the winter months, in the banks and public offices generally, where of necessity a vast amount of writing and accountants' work has to be done by gas-light. Price . . . . . £0 15 0 to 1 1 0

THE INVENTION OF SPECTACLES.*

"That the ancients had no knowledge of optic glasses is most evident from their universal silence in this matter; their most learned and inquisitive philosophers making no mention nor the least hint thereof in their writings, and doubtless, a contrivance of that universal use, beneficial to all old men, both in reading and writing, could never have been so concealed as that the least footsteps thereof should not remain to posterity.

"The most learned Monsieur Spoon in his *Recherches Curieuses d'Antiquité, dissert.* 16, inserts a letter of Signor Redi to Paulus Falconerius, concerning the time when Spectacles were invented; and this he fixes between 1280 and 1311, from the testimony of a manuscript chronicle in Latin, in the library of the Friers Preachers at Pisa, folio 16, in which a certain Frater Alexander de Spina lays claim to the *first* publication of the making *Ocularia* by a person who refused to communicate the process to him. Spina was a native of Pisa, and died there 1313. Signor Redi has in his library a manuscript written An. 1299, *Di Governo della Famiglia di Scandro di Pipozzo*, in which there is a passage as translated into English:—

"'I find myself so pressed by age, that I can neither read nor write without those glasses they call Spectacles, lately invented to the great advantage of poor old men, when their sight groweth weak.'

"The Italian *Dictionary de la Crusca*, on the word *Occhiale* makes this remark: that Frier Jordan de Rivalto, who died at Pisa, An. 1311, in a book of sermons which he writ An. 1305, tells his auditory that it is not twenty years since the art of making Spectacles was found out, and is indeed one of the best and most necessary inventions in the world.

"From all which we may be pretty certain that Spectacles were well known in the thirteenth century, but not much before. But who the happy man was that first hit upon this lucky thought may yet be questioned. It is true indeed, if we credit the forementioned chronicle of the convent at Pisa, Frier Spina makes as fair a challenge to the invention as the first author, who refused to communicate it. But I am apt to believe, that, whoever this close man was that would not impart to Spina, he was a Frier; and that these monkish men, and Jordan amongst the rest, had this invention whispered amongst themselves before it was publick; and that they all had the first hint thereof from our countryman Frier Roger Bacon. That this learned Frier Roger Bacon, who died An. 1292, and lyes buried at Oxford, did perfectly well understand all sorts of optick glasses shall be plainly made out from the natural and easy sense of his own words, in his book of Perspective: whereby we shall find, that he not only understood the effects of single convex and concave glasses, but knew likewise the way of combining them so as to compose some such instrument as our Telescope. This perhaps will be looked upon as a great paradox, and as a great partiality in an English author to his countryman; especially considering how universally the contrary has prevailed: the votes of most learned men having conferred the honour of the invention on other pretenders. But if from the unconstrained words of his books we plainly make out this assertion, I hope the attempt may not be counted unreasonable or partial."

Our author then goes on to quote from Frier Roger Bacon's book, *Perspective*, Part III., Distinction 2, Chapter iii., to show that he knew what a Concave and Convex glass was; and after several quotations in Latin from Roger Bacon's works, gives a translation from his epistle *Ad Parisiensem*, of the secrets of Art and Nature, Cap. 5. "Glasses or diaphanous bodies," says he, "may be so formed that the most remote objects may appear as just at hand, and contrarily. So that we may read the smallest letters at an incredible distance, and may number things though never so small, and may make the stars as near as we please. This, I think, is so express in the point, that it leaves no room to doubt but that he had some admirable secret in Optick Glasses." For further most interesting information on this subject, we refer our readers to Professor Smith's Book, *Remarks upon Articles* 18 *and* 89, *chapter* iii., *vol.* 2.

We may mention that an inscription is said to have been on the tomb of Salvino d'Armati, a Florentine, who lived in or about the 13th century, which would infer that he was the inventor or discoverer of the the use of Lenses as an aid to defective vision. Also, we note that the Chinese have long used Spectacles made of Rock Crystal or Pebble, worked to Convex or Concave forms by the aid of Corundum or Adamantine Spar. They are circular in form and of very large diameter, mounted in metal frames, and supported and held to the face by weighted silk cords slung over the ears. For reducing the painful glare of sunshine, the Chinese make use of thin plates of a mineral they call Cha-she or Tea Stone, from its colour resembling an infusion of black tea; probably this is smoky quartz or allied to the Scotch Cairngorum, mounted similarly to the Spectacles above described.

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* *A Compleat System of Opticks.* By ROBERT SMITH, LL.D., King's Professor of Astronomy, Cambridge, 1738.

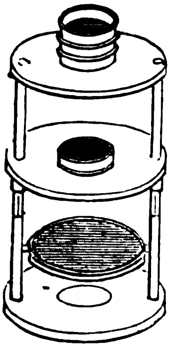


Fig. 1145.

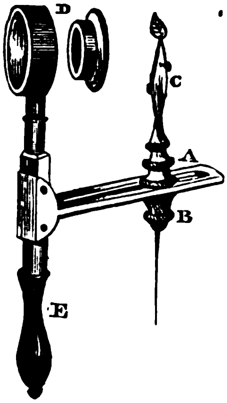


Fig. 1141*.

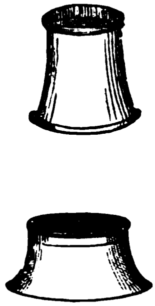


Fig. 1149.

Fig. 1144*.

MAGNIFIERS AND POCKET MICROSCOPES.

No.	Article	Each. £	s.	d.	Each. £	s.	d.
1141*	**Flower Microscopes**, folding up into convenient size, with neat cases for the pocket (fig. 1141*) . . .	0	5	6	0	6	6
1142	**Gardeners' Microscope** in case (fig. 1142)	0	3	6	0	5	0
1143	**Seed Microscopes**, with glass body, in case . . 2s.	0	4	6	0	7	6
1144	**Beetle or Insect Microscopes**, convenient for examining living insects . . . . 3s. 6d.	0	4	6	0	7	6
	Ditto ditto large size, best mounted (fig. 1144°)	0	10	6	0	15	0
1145	**Botanical Microscopes**, with three powers, mirror, &c., in pocket case (fig. 1145)	0	15	0	1	1	0

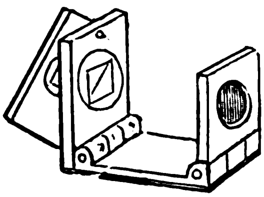


Fig. 1148.

Fig. 1142.

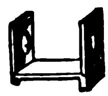


Fig. 1148*.

Fig. 1146*.

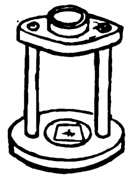
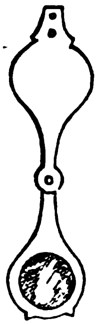
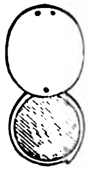


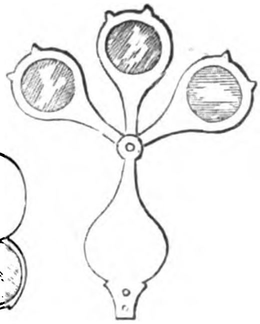
Fig. 1146.

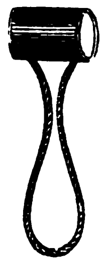
No.	Article	£	s.	d.	£	s.	d.
1146	**Cloth Microscopes or Linen Provers**, for ascertaining the number of threads in a given space of linen, cloth, &c., in round case (fig. 1146 and 1146°.) . . .				0	2	6
1147	Ditto ditto for coarse goods				0	5	6
1148	Ditto ditto **folding** for pockets (figs. 1148 and 1148°) 2s. 6d.	0	3	0	0	5	6
1149	**Watchmakers' and Engravers' Magnifiers** (fig. 1149) 1s.	0	1	6	0	2	6
1150	**Pocket Magnifiers**, in horn mountings (fig. 1150) .	0	2	0	0	2	6
1151	Ditto ditto, two lenses	0	3	6	0	4	6
1152	Ditto ditto, three ditto (fig. 1152)	0	4	0	0	5	0
1153	Ditto ditto one, two, or three lenses, in Tortoise-shell mountings . . . . 6s.	0	10	6	0	15	0
1154	Ditto ditto Tortoise-shell and Gold, Pearl and Silver mountings with Single or Double Lenses, prices various (fig. 1154).						

FIG. 1155*.









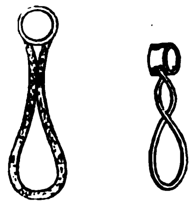


FIG. 1150. FIG. 1152. FIG. 1155.

No.	Article		Each. £ s. d.	Each. £ s. d.
1155	**Stanhope Lenses,** in German silver mountings (figs. 1155 and 1155*) . , ...	2s. 6d.	0 3 6	0 5 0
1156	Ditto ditto, in Silver ditto		0 10 6	0 15 0

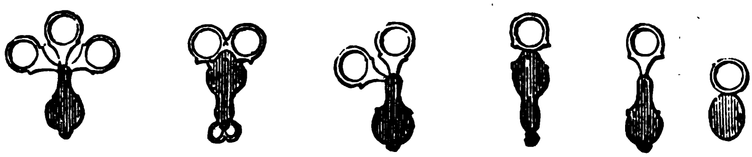


FIG. 1154.

No.	Article		
1157	**Stanhope Lens,** mounted with shade for the eye, and tube for improving the definition, magnifying power 180 diameters (fig. 1157)		0 12 6

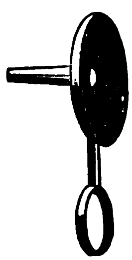


FIG. 1157.

This powerful and convenient lens is the invention of Lord Stanhope. The portability, low price, and the facility with which it can be used, recommend it strongly. With it may be seen the animalculæ in water, eels in paste and vinegar, farina of flowers, the down of moths, &c.; and if a drop of solution of salt be spread lightly over the end of the lens, and viewed without delay, the formation of crystals will be beautifully seen.

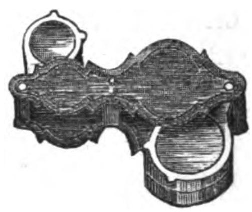


FIG. 1161.

No.	Article			
1158	**Coddington's Spherical Lens,** in German silver mounting		0 3 6	0 5 0
1159	Ditto ditto in pocket case		0 10 6	0 15 0
1160	Ditto ditto in silver		0 15 0	1 5 0
1161	**Pocket Magnifier,** with two plano-convex lenses, diaphragm, and a Stanhope or Coddington lens, in tortoise-shell mountings (fig. 1161) .	12s. 6d.,	0 16 6	1 5 0

The most useful pocket magnifier or microscope introduced, magnifying power 10 to 80 diameters.

VARIOUS OPTICAL INSTRUMENTS.

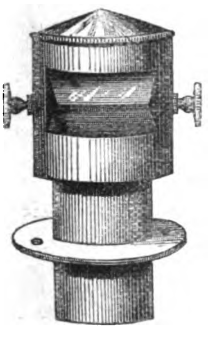


FIG. 1189.

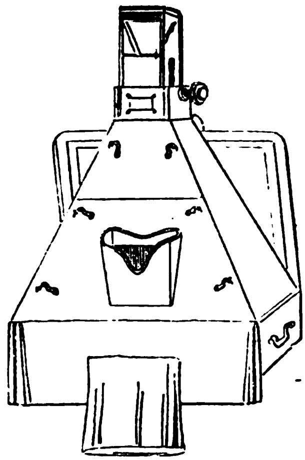
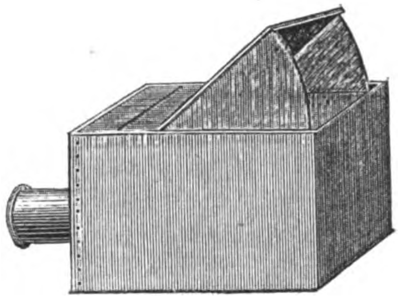


FIG. 1187.

FIG. 1188.

		Each.			Each.		
		£	s.	d.	£	s.	d.
1162	**Concave and Convex Mirrors,** Silvered Glass, in turned wood frames . . . . 16s., 21s.	2	2	0	5	0	0
1163	**Multiplying Mirrors** . . . . . . 10s. 6d.	1	5	0	1	10	0
1164	**Black Mirrors,** for Artists	1	1	0	1	16	0
1165	**Burning Glasses,** in Horn mountings . . . . 2s.	0	2	6	0	5	0
1166	**Glass Prisms,** for showing Decomposition of Light, of various sizes . . . . . . 2s. 6d., 5s.	0	10	6	1	6	0
1167	**Glass Prisms,** two in a neat box for exhibiting the Decomposition of Light into the Prismatic Colours and their Recomposition into White Light, &c. .	0	5	6	0	6	6
1168	**Prism Compound** of Flint, Crown, and Plate Glass .				1	10	6
1169	**Prisms** mounted with Ball and Socket joint adjustment on Brass foot	1	16	0	2	2	0
1170	**Hollow Glass Prism,** for experiments on the refraction of Fluids, and for Spectroscopes	1	1	0	1	10	0
1171	**Multiplying Lenses** in frame	0	3	0	0	5	0
1172	**Claude Lorraine Glasses,** for studying the effect of colour upon Landscapes, &c.	0	15	6	1	1	0
1173	**Colour Tops,** a simple contrivance for exhibiting the recomposition of white light from colours . . .				0	10	6
1174	**Apparatus** for ditto ditto, on a larger scale, with multiplying wheel, on Stand with Circular Prismatic Disc (fig 1199*)				2	10	0
1175	**Dr. Gorham's Kaleidoscopic Colour Top,** with perforated discs and coloured diagrams, complete; in box .				1	1	0
1176	**Concave Lenses,** in frame, for viewing engravings, &c. .	0	1	0	2	2	0



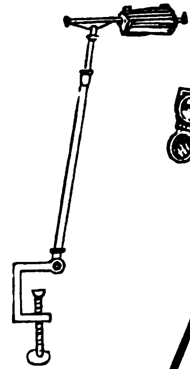


FIG. 1186.

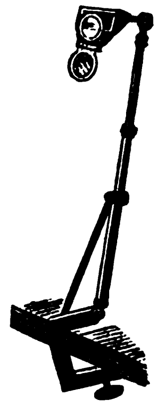


FIG. 1182.

FIG. 1199*.

FIG. 1183.

No.		Each. £ s. d.	Each. £ s. d.
1176*	**Graphoscopes**, see page 260		
1177	**Diagonal Print Machines**, for viewing Prints, &c. .		3 3 0
1178	**Cosmoramic Frames and Glasses**	0 15 0	2 2 0
1178*	**Print or Map Lenses**, various mountings and sizes, see page 254		
1179	**Cylindrical Magnifying Lenses**, in German silver mountings . . . . 15s.	1 1 0	1 15 0
1180	**Cylindrical Mirrors**, with six diagrams		1 10 0
1181	**Mirrors, Conical**, with twelve diagrams . . .		1 15 0
1182	**Camera Lucida**, Wollaston's (*Chambre Claire*), for drawing in true perspective, in case (fig. 1182) . .	1 10 0	2 10 0
1183	Ditto ditto, best form with Shades, &c. (fig. 1183) .	3 3 0	5 5 0
1184	**Portable Stand** for ditto.		2 2 0
1185	**Camera Lucida**, for Microscope . . . . See Micro Section		
1185*	**Beale's Neutral Tint Camera or Reflector,** *for ditto. See also*		
1186	**Draughtsman's Camera Obscura** (*Chambre Noire*), for sketching (fig. 1186) . . . . 21s.	1 15 0	2 2 0
1187	Ditto ditto improved **Portable** (fig. 1187) . .		6 6 0
1188	**Cosmorama or Camera Obscura, for Gardens**, &c., fitted up to order (fig. 1188).		
1189	**Prisms, Plano-Convex**, in Brass mountings, with sliding adjustment (fig. 1189) for constructing Garden Cameras (as fig. 1188), of various dimensions and foci 38s., 45s.	2 10 0	5 10 0

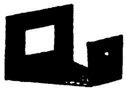


FIG. 1203†.

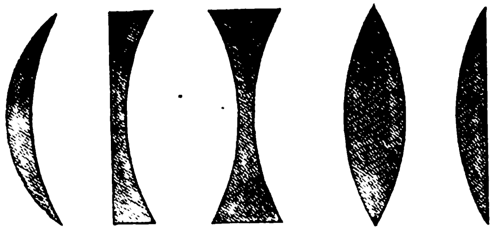


FIG. 1189*

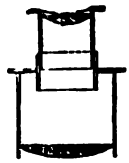


FIG. 1203‡.

No.	Article	Each. £ s. d.	Each. £ s. d.
1189°	**Set of Five Lenses** of various forms and curves, (fig. 1189°), with a small Prism to illustrate the Science of Optics, in a hinged case		1 5 0
1189†	**Model of the Human Eye,** showing the position of various humours and Lenses, and for demonstrating the cause of Presbyopia or Long Sight; Myopia, Short or Near Sight, &c., &c. In Mahogany Box . . .		6 6 0
1190	**Kaleidoscopes,** with two or three reflecting planes 2s. 6d.	0 5 6	1 10 0
1191	**Chromeidoscope,** a modification of the Kaleidoscope .	1 10 0	2 2 0
1192	**Debuscope,** or Table Kaleidoscope, of Solid Glass . .		1 16 0
1193	Ditto, with Plated Metal Reflectors	0 7 6	0 10 6
1194	**Spectroscope,** for Chemical research. See Chemical Section		
1195	**Photometers,** Wheatstone's	2 10 0	3 3 0
1196	Ditto, for Gas Testing . . . See Chemical Section		
1197	**Radiometer,** Crook's . . . . ditto ditto		
1198	**Goniometer, Wollaston's,** for measuring the angles of Crystals		5 5 0
1199°	**Anorthoscope,** with twelve diagrams (fig. 1199°) . .		2 2 0
1200	**Polemiscope,** by means of which any object may be seen, though an opaque body be placed before it . .		3 3 0
1201	**Phantascope,** for exhibiting the illusion effected by a concave mirror, projecting figures in air . . .		4 4 0
1202	**Polyorama,** with six views, so constructed that day and night effects are produced by means of reflected and transmitted light		2 2 0
1203	**Extra Sets of Views** for ditto		1 1 0
	Lenses or Prisms of all kinds made to order.		
1203*	**Videoscope,** for Reading, Drawing, Engraving, &c., having a clamp to screw the Instrument to the table, with joint and sliding adjustment with clamp . .		1 10 6
1203†	**Visuometer, Photographic** (fig. 1203†), for enabling the artist to judge the effect of a landscape, folding for the pocket		0 4 6
1203‡	**Focussing Glass, Photographic** (fig. 1203‡), for obtaining a perfectly sharp image on the focussing glass of the Camera	0 12 6	0 16 0

Models and Diagrams to explain and demonstrate the Elementary Laws of Optics, the Theory of Vision, the construction of Refracting and Reflecting Telescopes, Simple, Compound, and Solar Microscopes, &c., &c., supplied to order.

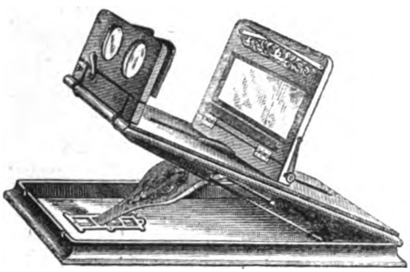


FIG. 1204.

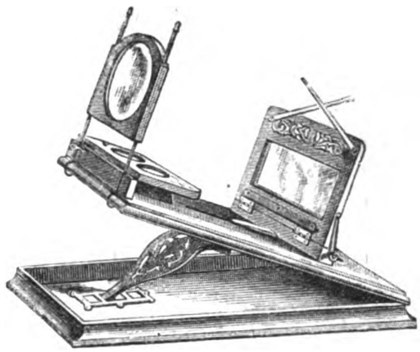


FIG. 1204*.

NEGRETTI AND ZAMBRA'S GRAPHOSCOPE,

FOR VIEWING PHOTOGRAPHS, DRAWINGS, AND PICTURES OF EVERY KIND,

As constructed and Patented by its Inventor, Mr. C. J. ROWSELL, and shown in the class "Scientific Inventions," at the **International Exhibition** (1871).

So simple is this instrument, that little need be said as to the mode of using. It can be focussed to suit any sight — the oldest or youngest, the longest or shortest. Plain or Coloured Photographs, when viewed through the Large Lens, will be found to stand out with a roundness and reality of natural objects. It occupies little space, cannot get out of order, and is an ornament to any drawing-room. The Graphoscope may be used either by day or night.

In the beautiful **Photographic "Nature Printing,"** there is much that the unassisted eye cannot perceive, but which appears among the distincter portions portrayed, as a dark or light mass only. The **Graphoscope**, by a simple but effective arrangement, and a powerful Lens easily adapted to any focus, "**brings out**" and gives a **Stereoscopic** life-like effect to this, and to the whole subject in a very pleasing and beautiful manner; also, by a simple combination, it forms a perfect **Stereoscope** for both Opaque and Transparent views. The **Graphoscope**, with an appropriate selection of Coloured or Plain Photographs, forms a **most elegant Wedding or other Present.**

		Each. £	s.	d.	Each. £	s.	d.
1204	**No. 1. Graphoscope, Ordinary Size, with Stereoscope,** *Mahogany* (figs. 1204 and 1204*)				2	12	6
1205	**No. 2.** do do. *Walnut* . .				3	3	0
1206	**No. 3. Large Size** do. *do.*				5	5	0
	No. 3* Extra do. do.	6	6	0	7	7	0
1207	**No. 4. The Piccolo, a small Instrument**	1	10	0	1	16	0

Negretti and Zambra have always in Stock a collection of Photographic Views of London and various parts of the World—Photographic Flowers and views of the Crystal Palace, Sydenham—both coloured and plain, Statuary, &c., &c.

Plain Photographic Views, 2s. 6d., 4s. 6d.; Coloured Flowers and Views, 4s. and 5s.

A vase containing a bouquet of Natural Flowers placed in the field of the large lens forms an exceedingly interesting object. When the Graphoscope is used for this purpose it should have the easel turned down flat upon the base.

Cartes de Visite, Portraits, &c., are very effective under the Instrument.

STEREOSCOPES.

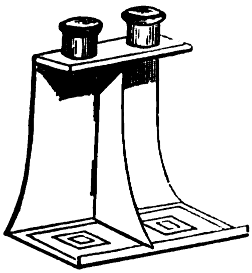


FIG. 1208.

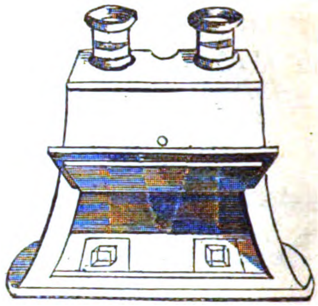


FIG. 1209.

		Each. £	s.	d.	Each. £	s.	d.
1208	**Stereoscopes,** plain metal or mahogany (fig. 1208) .	0	3	6	0	5	6
1209	Ditto ditto mahogany with brass adjusting eye-pieces (fig. 1209)	0	7	6	0	10	6
1210	**Stereoscopes,** divided form (fig. 1210), papier maché body, covered with leather, ard brass adjusting mounts, with glass mirror .				1	1	0
1211	Ditto ditto Walnnt or other woods, with ornamental mountings				2	2	0

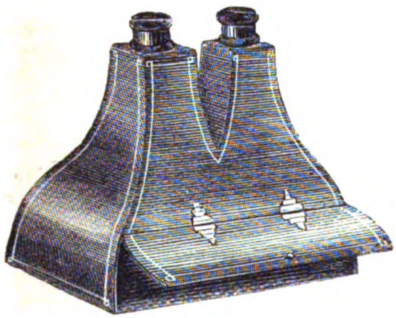


FIG. 1210.

FIG. 1212.

PATENT COSMORAMIC STEREOSCOPES.

		£	s.	d.	£	s.	d.
1212	**Cosmoramic Stereoscopes,** Mahogany or Walnut wood, with Prismatic Lenses (fig. 1212) . 7s. 6d., 10s. 6d.	0	15	0	1	1	0
1213	Dittto ditto various **Japanese Mounting** (fig. 1213) .	0	14	0	1	1	0

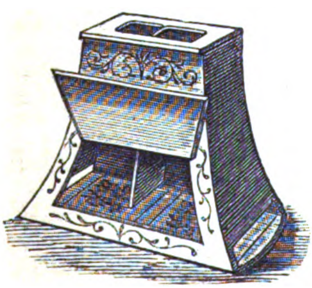


FIG. 1213.

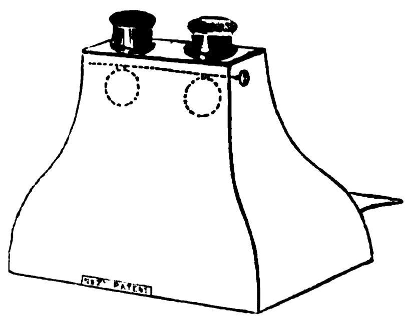


FIG. 1214.

PATENT STEREOSCOPES WITH ADDITIONAL LENSES ADAPTED FOR SHORT SIGHT.

		Each.			Each.		
		£	s.	d.	£	s.	d.
1214	**Patent Stereoscopes,** with extra Lenses for Short Sight, in Mahogany or Walnut wood (fig. 1214)	1	15	0	2	2	0
1215	Ditto ditto in Papier Maché, divided form, covered with leather and ornamental mounts of various forms	2	10	0	3	3	0

NEGRETTI AND ZAMBRA'S PATENT MAGIC STEREOSCOPES.

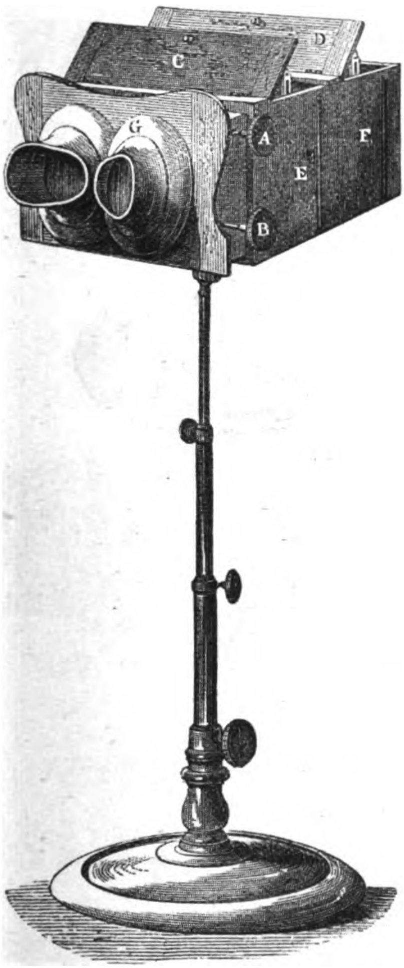


FIG. 1216.

The great advantage offered by the "Magic Stereoscope" over all other descriptions of the instrument is its power of enlarging the slides seen through it to such an extent as to render them perfectly real in appearance, as though the scenes themselves were actually presented to view.

Speaking of the Magic Stereoscope, the writer in the *Art Journal* says:—"This instrument possesses advantages over every modification which we have yet examined. After a careful examination of all the conditions of the Magic Stereoscope, we are bound to state that it is by far the greatest improvement which has been made in this most interesting instrument."

The prominent position the Magic Stereoscope has now for twenty years held, the favourable opinion expressed of its merits by its numerous purchasers, and the steady and increasing demand, not only in Great Britain, but in all our Colonies, in America, and on the Continent, and, moreover, the entire absence to the present time of any competing instrument of higher pretensions,—all combine to establish its great superiority, and to confirm the opinion concerning it expressed in the critique in the *Art Journal* quoted above.

Messrs. NEGRETTI AND ZAMBRA are the Sole manufacturers of Mr. COOK'S Patent Magic Stereoscope.

1216	**Patent Magic Stereoscope,** in Walnut, with Achromatic Lenses, on three-draw telescopic stand (fig. 1216), and rackwork adjustment for focussing				10	10	0
1217	Ditto ditto the instrument and base of the stand handsomely carved	12	12	0	15	15	0

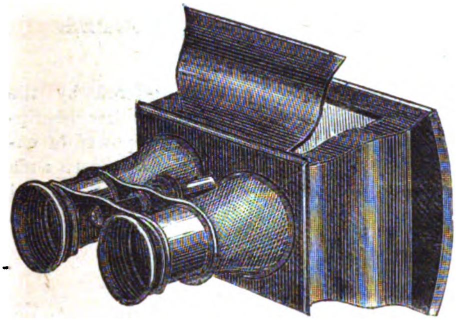


FIG. 1219.

FIG. 1223.

No.	Description	Each. £ s. d.	Each. £ s. d.
1218	**Negretti and Zambra's Patent Magic Stereoscope,** in its most perfect form, with Extra Sized Lenses throughout, the intermediate lenses, Patent Cylindrical, for insuring a perfectly flat, colourless field and freedom from distortion (as fig. 1216) . . from		18 18 0

NEGRETTI AND ZAMBRA'S ACHROMATIC STEREOSCOPES.

No.	Description	Each. £ s. d.	Each. £ s. d.
1219	**Achromatic Stereoscopes,** with **Opera Glass adjustment** (fig. 1519), in various plain mountings . . 25s.	1 15 0	2 2 0
1220	Ditto ditto ornamental mountings	2 2 0	3 3 0
1221	**Achromatic Stereoscopes,** with **Rack-work Adjustment** and **extra large** Achromatic Lenses, high magnifying power, suited for **Glass** Stereoscopic views	2 10 0	3 3 0
1222	Ditto ditto mounted on **Adjusting Stand** . .	4 4 0	5 5 0

No.	Description	Each. £ s. d.	Each. £ s. d.
1223	**The Cabinet Form Stereoscopes,** in Walnut, with Rackwork adjustment, mounted on Telescope stand, with Brass Slides and Clamps (fig. 1223)	5 5 0	6 6 0
1224	Ditto ditto Instrument and Stand Carved . .	7 7 0	8 8 0

FIG. 1225.

PATENT REVOLVING OR MAGAZINE STEREOSCOPES.

1225 **Magazine Stereoscopes,** to hold and exhibit twenty-five transparent Glass, or fifty Paper Slides.
£3 3 0 £4 4 0 £5 5 0

1226 Ditto ditto with **Achromatic Lenses** (fig. 1229)
£7 7 0 £8 8 0 £10 10 0

1227 **Magazine Stereoscope,** on a pedestal, to hold 100 **Glass** views, with convenient adjustments £12 12 0

1228 **Magazine Stereoscope,** very handsomely Carved and Ornamented, to hold 100 **Glass** views.
£23 0 0 and £30 0 0

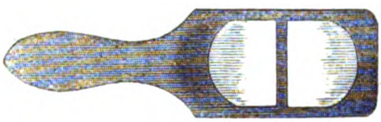


FIG. 1229.

			Each. £ s. d.	Each. £ s. d.
1229	**Hand Stereoscope** (fig. 1229), for rapidly looking over a series of Stereographs			0 15 6
1230	**Folding Stereoscope,** with Leather Cases .	10s. 6d.	0 15 0	1 5 0
1231	**Book Stereoscope,** with ditto . . .			0 10 6

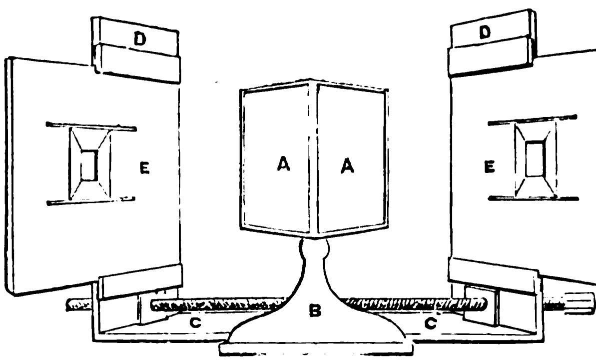


FIG. 1232.

1232 **Wheatstone's Reflecting Stereoscopes,** for viewing Large Photographs (fig. 1232), the earliest form of the instrument . £5 5 0 and £6 6 0

In the Appendix will be found a description and history of the Stereoscope.

GLASS STEREOSCOPIC VIEWS.

1233 **Negretti and Zambra's Series of Glass Stereoscopic Views,** Price 4s. and 6s. each:—

England.	Venice.	Egypt and Nubia.
London and Environs.	Germany and the Rhine.	Holy Land and Syria.
Scotland.	Belgium and Holland.	China.
Ireland.	Denmark.	Japan.
France.	Norway.	Siam.
Spain.	Sweden.	Moluccas.
Italy.	Russia.	Java.
Rome.	Constantinople and Athens.	India.
Switzerland.	America.	Pompeii.

STEREOSCOPIC VIEWS OF THE CRYSTAL PALACE.

1234 **Negretti and Zambra's Collection of Crystal Palace Views,** comprising all the most interesting views of the building and various Courts, Statuary, &c. The Crystal Palace subjects are published upon Glass and Paper.

Glass	£0 4 0 each
Paper	£0 1 0 „

PAPER STEREOSCOPIC VIEWS.

1235 **Paper Stereoscopic Views** of the following places, price 1s.

England.	Negretti and Zambra's Series of London Views.	Switzerland.
Scotland.		America.
Wales.	Egypt and Nubia.	France.
Ireland.	Holy Land.	Belgium.
English Lake Scenery.	India.	Spain.
Exteriors and Interiors of English Cathedrals.	China.	Holland.
	Italy.	Pompeii and Herculaneum.

BOXES AND CABINETS FOR PRESERVING STEREOSCOPIC PICTURES.

No.	Item	Each. £ s. d.	Each. £ s. d.
1236	**Plain Mahogany Boxes,** to hold 25 paper pictures .		0 10 6
1237	Ditto ditto to hold 100 paper pictures . .		1 1 0
1238	Ditto ditto better quality for Glass Views .	2 2 0	3 3 0
1239	**Elegant Cabinet Boxes,** to hold a **Stereoscope** with a selection of Glass and Paper views, &c., &c.; of various forms and mountings . . . . . . £3 3s.	4 4 0	5 5 0

Messrs. Negretti and Zambra received a **Prize Medal,** 1851. Honourable Mention, Paris, 1855. The Austrian **Gold Medal.**

Two Prize Medals, 1862, "For beauty and excellence of Photographic Transparencies, and adaption of Photography to Book Illustration;" and

"For many Important Inventions and Improvements, together with accuracy and excellence in Objects Exhibited."

Three Prize Medals,—Philadelphia.

OPERA GLASSES, RACE GLASSES, FIELD GLASSES,

AND

CAPTAIN'S BINOCULAR GLASSES.

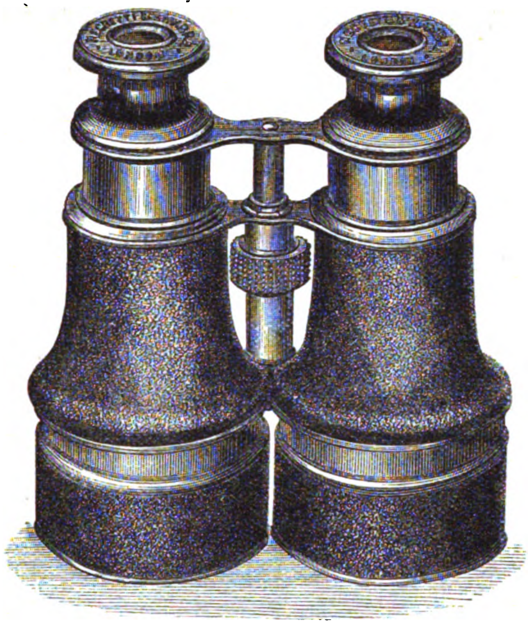


FIG. 1256.

SINGLE ACHROMATIC OPERA GLASSES.

FIG. 1242. FIG. 1240.

No.	Description	Each. £ s. d.	Each. £ s. d.
1240	**Achromatic Perspective Glasses,** simple form, black body, with plated draws (fig. 1240) . .		0 12 6
1241	**Achromatic Pers;ectiveGlasses,** enamelled black body, one gilt draw, called the "Exhibition Glass"	0 12 6	0 15 0
1242	Ditto, with **Ivory** body and gilt draw (fig. 1242) . . 16s.	0 18 0	1 10 0
1243	**Sydenham Waistcoat Pocket Glass,** with Achromatic combination of six lenses, of extraordinary defining and magnifying power :—		
	Plain Japanned Metal mounting		1 5 0
	Ditto ditto body covered with leather .		1 7 6
	Ivory body and gilt slide		1 10 0
	Tortoise-shell ditto ditto		2 2 0
1244	**Tom Th mb Opera Glass for the Watch Chain** . .		0 15 0
1245	**Achromatic Perspective Glasses,** larger sizes, gilt metal, and Ivory mountings	1 15 0	2 15 0

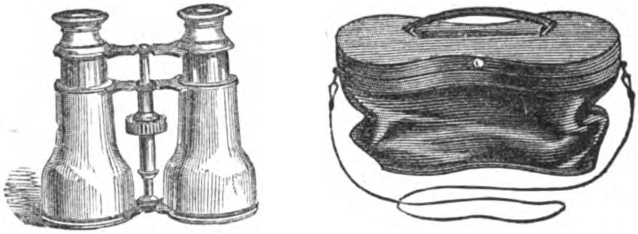


FIG. 1246.

BINOCULAR ACHROMATIC OPERA GLASSES.

1246 **Binocular Achromatic Opera Glasses,** with screw adjustments, the object glasses and eye lenses warranted of superior quality, with flexible leather cases and sling to each instrument (fig. 1246).

	Each. £	s.	d.	Each. £	s.	d.
Ditto ditto, the body and slides all black, 25s., 30s., 42s.	3	3	0	4	4	0
Ditto ditto, the body Ivory, with slides and adjustments gilt . . . . 50s., 63s., 70s.	4	4	0	5	5	0
Ditto ditto, the body and slides all Ivory, 90s., 110s., 126s.	8	8	0	10	10	0
Ditto ditto, the body Pearl, with Gilt slides and bars . . . . 105s., 126s.	7	7	0	9	9	0
Ditto ditto, the body and slides all Pearl 126s., 147s.	9	9	0	11	11	0

1247 **Opera Glasses, with Moveable Centres,** to change the position of the lenses to adapt them to suit the width between different eyes, from 10s. to 15s. each extra on all the prices quoted in this list.

FIG. 1248.

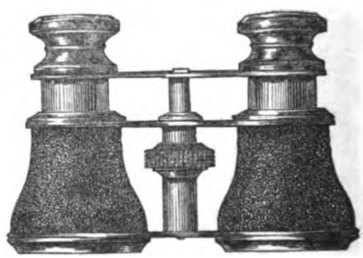


FIG. 1248*.

1248 **Binocular Opera Glasses,** of our best manufacture, with **Triple Achromatic eye** Lenses and **Triple Object Glasses,** or **12-lens Combination:—**

	£	s.	d.	£	s.	d.
the body and slides all enamelled black 63s.	4	4	0	5	5	0
Ditto ditto, the slides and adjustments black and the body covered with leather (figs. 1248 and 1248*) . . . . 84s.	5	5	0	6	6	0
Ditto ditto Ivory body, Gilt slides, mountings, and adjustments . . . . . 84s., 105s.	6	6	0	7	7	0

FIG. 1249.

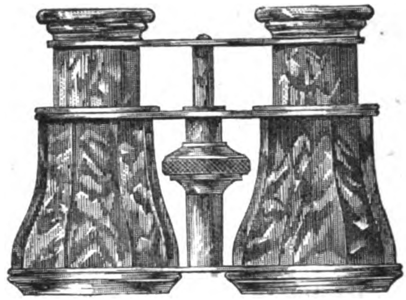


FIG. 1249*.

1249 **Binocular Opera Glasses, Ivory body,** best double Gilt slides and adjustments, **Chased Mountings,** Lenses and fittings of the very best manufacture six sizes (fig. 1249 and 1249°)

£5 5s., £6 6s., £7 7s., £8 8s., £9 9s., £10 10s.

Adjusting Centres, to any of the above opera glasses, 10s. to 21s. each, extra.

The above prices are for the VERY BEST QUALITY of lenses and mountings; similar sizes of Opera Glasses can be supplied of inferior manufacture at lower rates.

1250 Messrs. Negretti and Zambra have always in stock an extensive and costly assortment of Binocular Achromatic Opera Glasses, in the most elegant and recherché mountings, fitted with lenses of the very finest quality, suitable for Presentation: In Solid Tortoise-shell—Tortoise-shell and Gilt—Tortoise-shell beautifully inlaid with Solid Gold of exquisite design—Enamelled in various brilliant colours on Solid Silver or Brass—Solid Silver elaborately chased—Silver inlaid with Solid Gold of the most artistic patterns—**Aluminium** and **Pearl** (fig. 1249*), &c., &c.

£5 5 0 £6 6 0 £7 7 0 £8 8 0 £10 10 0 to £25 0 0

1251 **Oval Lens Opera Glass,** in Black, or Ivory and Gilt Mountings, *supplied to Order* . . £4 4 0 5 5 0 6 6 0

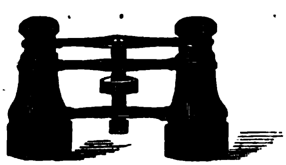


FIG. 1252.

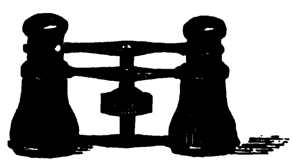


FIG. 1252*.

DUCHESSE AND EMPRESS, TWELVE-LENS OPERA GLASSES.

1252 These elegant little Binoculars, by a novel arrangement of Achromatic Lenses in the eye tubes and object glasses, combine a large field, high magnifying power, and perfect definition, in the smallest possible size.

Duchesse or Empress 12-lens Opera Glasses:—

In plain japanned or bronzed metal mountings (figs. 1252 and 1252*) £2 10 0 £3 3 0

No.	Article	Each £	s.	d.	Each £	s.	d.
1252*	**Duchesse or Empress 12-lens Opera Glasses:—**						
	Ditto body covered with leather	2	12	0	3	3	0
	Ditto ditto, with Ivory body, with Gilt slides .	3	3	0	4	4	0
	Duchesse or Opera Glasses, 6-lens achromatic combination, in Bronzed metal mounts covered with Leather . . . . £1 1s.	1	5	0	1	10	0
	Ditto ditto, Ivory and Gilt mountings .				2	2	0
1252†	**Bijou,** the smallest Binocular manufactured, Ivory and Gilt Mountings	2	10	0	3	3	0
	Ditto Solid Tortoise-shell or Pearl Mountings .	5	5	0	6	6	0
	Ditto Solid Pearl with Aluminium mountings .				5	5	0

An elegant Velvet or Morocco leather folding case given with each of the above.

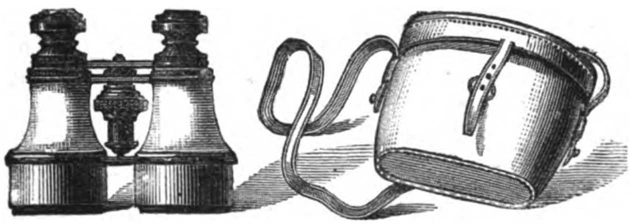


FIG. 1259.

RACE AND RECONNOITREING GLASSES.

No.	Article	£	s.	d.
1253	**Achromatic Race Glasses,** with Sun Shade, in strong Metal Mountings, Enamelled, with leather case and strap 42s., 50s.; 63s.	4	10	0
1254	**Achromatic Reconnoitreing or Race Glass,** of the best quality, in strong Metal Mountings, Bronzed, the body covered with leather, with case and strap (fig. 1255) . . . . . 70s.; 84s.	5	5	0
1254*	**Achromatic Reconnoitreing Glass, with Double adjusting Tubes,** giving extended range; a very powerful instrument, with sling case and strap	8	8	0
1255	**Achromatic Race Glass,** mountings the same as above, with **Adjusting centre,** to change the position of the lenses to suit the width of different eyes. With case and strap (fig. 1255) 84s.; 105s.	5	10	0
1256	**Twelve-lens Achromatic Binocular Race Glass or Staff Officers' Glass** (fig. 1256), (having Triple Combination Eye and Object Lenses) very powerful, with great field of view, with solid leather Case and Strap . . . . 105s.; 126s.	7	7	0
1256°	**Negretti and Zambra's Military Binocular,** specially designed for service in the Field, mechanically Strong, of little weight, Optically of very high power . . . . . . 126s.	7	7	0
1257	**Binocular Achromatic Deer Stalking Glasses, with double adjusting tubes.** See Binocular Telescopes.			

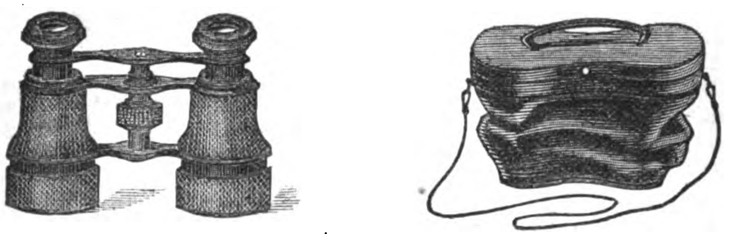


FIG. 1258.

THE FIELD GLASS.

Without the bulk and weight of a large Race Glass, the **Field Glass** will be found invaluable; its small size admits its being carried by ladies or gentlemen where larger instruments would be inconvenient and annoying. Equally adapted for land or sea, the opera, picture gallery, or public meeting. By an achromatic arrangement of 12 lenses, the highest magnifying power and most extended field are obtained with the utmost economy of space.

		Each. £ s. d.	Each. £ s. d.
1258	**Binocular Field Glass,** smallest size, in bronzed metal mounting, and the body covered with leather, with sun shades and convenient flexible case (fig. 1258) .		4 4 0

FIG. 1259*.

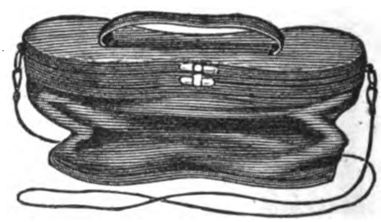


FIG. 1259†.

1259 **Field Glass,** (figs. 1259, 1259*, 1259†), specially adapted for **Military Service**:—with either Flexible or Solid Leather Case and Strap.
2nd size £4 10 0, 3rd size £5 10 0, 4th size £6 10 0

1260 **Ladies' Binocular Race or Field Glasses,** in Ivory and Gilt or Tortoiseshell and Gilt mounts . £5 5 0 6 6 0 8 8 0
Ditto ditto, **Aluminium** . . 7 7 0 8 8 0 10 10 0

With Flexible Leather or Velvet Cases (fig. 1260).

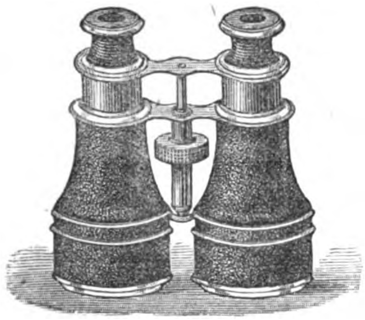


FIG. 1260.

FIG. 1262*.

FIG. 1262.

		Each. £ s. d.	Each. £ s. d.
1261	**Binocular Field Glasses,** with **Revolving Eye-pieces,** by which the magnifying power and field is varied to suit very **Near, Medium,** or very **Distant** objects, indicated on the adjusting bar as **Opera, Field,** and **Marine,** Four sizes (fig. 1262) £5 5 0 £6 6 0	7 7 0	8 8 0
	With Leather Sling Case and Strap.		
1262	**Revolving Eye Lens, Binocular, Aluminium Mountings** (fig. 1262) £15 15 0	16 16 0	21 0 0

FIG. 1255.

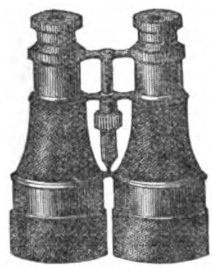


FIG. 1263.

FIG. 1263*.

NAVAL, MILITARY, CAPTAINS', OR PILOTS' BINOCULAR NIGHT GLASSES.

These instruments having been brought to very high perfection, are now universally used as look-out glasses in the navy and merchant service, also by military officers for reconnoitreing, &c.

1263	**Binocular Look-out Glasses, or Horizon Sweeps,** extra large size, Lenses and Mountings, very strongly mounted	6 6 0	8 8 0
	With Solid Leather Case and Strap (figs. 1263 and 1263*).		

Prize Medal, 1851. Two Prize Medals, 1862.

FOR MANY IMPORTANT INVENTIONS, ACCURACY, AND EXCELLENCE.

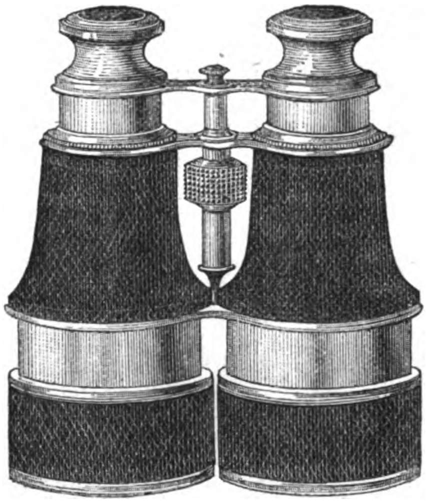


FIG. 1272.

NEGRETTI AND ZAMBRA'S ALUMINIUM BINOCULARS.

The only novelties in Opera and Field Glasses exhibited at the International Exhibition of 1862 were two by Messrs. Negretti and Zambra; *viz.*, the use of Rock Crystal for lenses, and Aluminium for the mountings; the extreme hardness and brilliancy of the one, and the wonderful lightness of the other, render them eminently useful in the construction of Field Glasses, &c.

The principal use of Rock Crystal is for instruments required for service in **Tropical climates,** where the great heat, combined with moisture, cause the ordinary glass lenses to become dull and stained. The Rock Crystal retains its polish, gives a very brilliant image, and is not so liable to become scratched as Glass.

1270	**Rock Crystal 12-lens Combination Binocular Field Glasses,** with Solid Leather Sling Cases and strap .	£7 7 0	8 8 0

The difference of weight between **Aluminium** and the usual metal mountings of Field Glasses, &c., is so great as always to excite astonishment, certainly one-third less; so that a very large instrument can be used with the greatest ease and comfort. This extraordinary lightness is very valuable in hot climates, where the slightest exertion becomes distressing, and a useful instrument is often thrown aside on account of its weight. Negretti and Zambra are now manufacturing Aluminium Opera and Field Glasses in a variety of sizes and forms, fitted with the very finest lenses, weighing about one-third less than the ordinary instruments.

1271	**Aluminium Opera Glasses** . . .	£5 5 0	7 7 0	8 8 0
1272	**Ditto Field Glasses** (fig. 1272) .	£10 10 0	11 11 0	12 12 0

TELESCOPES.

THE INVENTION OF THE TELESCOPE.

It is somewhat difficult to determine to whom we are indebted for the Telescope, and what is the exact date of its invention. No discoveries have been handed down to us which would lead to the certain conclusion that it was known to the ancients. Before the end of the 13th century glass lenses were used to remedy and assist defects in vision. There can be no doubt that the celebrated Roger Bacon, who died in 1292, was aware that lenses might be so arranged as to magnify the appearance of objects seen through them; but there are good reasons for believing that his knowledge was derived only from reflection, and that he never carried his theory into practice. Whatever were the ideas or the experiments of the learned, the Telescope was not much known before the beginning of the 17th century. If, as some have supposed, its existence may be traced back to a much earlier period, its importance was not discovered until an accidental circumstance brought its wonderful power into public notice. The children of a Spectacle maker residing at Middleburgh, in Holland, playing in their father's workshop, observed that when they held between their fingers two spectacle glasses at some distance, one before another, and looked through them at the weathercock of the church, it seemed inverted, but very near to them, and much increased in size. Having called the attention of their father to this strange sight, he mounted two glasses on a board, supported in two brass circles in such a manner that the distance between the Lenses might be increased or diminished at pleasure. Many persons visited his workshop to see his experiments, which afforded amusement and awakened curiosity. To this incident we may probably attribute the expression of Huygens, an Astronomer of the 17th century, who described the Telescope as a "casual invention." For some time the contrivance of the Middleburgh Optician remained unimproved, and was applied to no valuable purpose; at length, about the year 1609, two workmen of the same city, by giving to his discovery a new form, made all the honour of it their own.

These men, whose names were Zachariah Jans, or Jansen, and Hans Lapprey, Lipperhay, or Lippersheim, are said to have been Spectacle makers. One of them placed the glasses in a tube, the inside of which he blackened to prevent the glare which would be occasioned by reflected light from the inside of the tube, and which would produce indistinct vision. The other placed his glasses in tubes sliding one within the other, to adjust the instrument and make it portable. When Jansen had completed his Telescope, he presented it to Prince Maurice of Nassau. The United Provinces were then at war with France, and the prince, perceiving the advantage which he might obtain in the field over the enemy by means of this gift, desired that the invention should be kept a profound secret.

Galileo, who was born at Pisa, 1564, has been frequently said to be the Inventor of the Telescope, because he was the first who successfully applied it to Astronomy. In the following passage, translated from a small work written in Latin, which he published in 1610, under the title of *Sidereus Nuncius*, he confutes this notion, and shows what prompted his first efforts to make such an instrument.

"Nearly ten months ago, it was reported that a certain Dutchman had made a Perspective, through which many distant objects appeared as distinct as if they were near. Several experiments were reported of this wonderful effect, which some believed, and others denied; but having it confirmed to me a few days after by a letter from the noble James Badovere, of Paris, I applied myself to consider the reason of it, and by what means I might contrive a like instrument, which I attained to soon after by the doctrine of refractions. At first I prepared a Leaden Tube, in whose extremities I fitted two spectacle glasses, both of them plain on one side and on the other side, one of them spherically convex and the other concave. Then applying my eye to the concave, I saw objects appear pretty large and pretty near to me; there appeared three times nearer, and nine times larger a surface than to the naked eye. And soon after I made another, which represented objects above sixty times larger; and at last, having spared neither labour nor expense, I made an instrument so excellent as to show things almost a thousand times larger, and about thirty times nearer than to the naked eye."

After describing some experiments with his Telescope, Galileo goes on to state that he was at Venice when he heard of the effects of Prince Maurice's instrument, but nothing of its construction, and that directly upon his return to Padua, he solved the problem, and made his instrument, which he presented to the Doge of Venice, who, to do him honour for his grand invention, gave him the Ducal Letters which settled him for life in his Lectureship at Padua, and doubled his salary, making it treble the amount paid to his predecessors. Galileo's famous Telescope is said to have been about 3 feet long.

Limited space will not permit our following up the gradual improvement of the Optic Tube to the almost perfect instrument of the present time. Not much advance was made until the time of Sir Isaac Newton, who, with others, devoted a vast amount of time and thought to the construction of Astronomical Telescopes. Newton, after making the singular statement *that he considered the improvement of the Refracting Telescope to be desperate*, appears to have abandoned further inquiry or experiment. In 1729, about two years after the death of Newton, Mr. C. M. Hall, of More Hall, Essex, constructed an Achromatic Telescope. The history of this invention was for a long period lost, and it was not until long after the Mr. John Dollond, of London, had made many most valuable discoveries and improvements in connection with the Achromatic Telescope, that Mr. Hall's secret was published. From this period, the Telescope was further improved by Ramsden, Blair, Tulley, Guinand, Lerebours, and Fraünhofer, Lord Rosse, and many others, until it has become one of the most valuable instruments in Physical Science.

In Smith's *Optics*, published in 1738, a double or *Binocular Telescope* is figured and fully described; also, in the Special Loan Collection of Scientific Apparatus at South Kensington of 1876, was exhibited an early example of a *Double Perspective*, most probably made in Holland about 1700. In this same collection were exhibited a number of most interesting specimens of early Optical Instruments, amongst others, two Telescopes with broken Lenses, of Galileo, the property of the *Royal Institute of Studii Superiori, Florence.*

For further information on this subject, see Dr. R. Smith's *Opticks*, Brewster's *Life of Newton*, *Library of Useful Knowledge*, Natural Philosophy, Section Optics, Lardner's *Optics*, Article Telescope in the *Penny Cyclopœdia* and *Encyclopœdia Britannica, &c., &c.*

TELESCOPES.

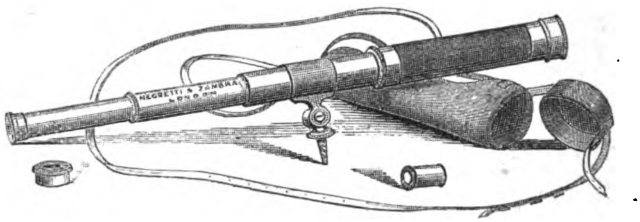


FIG. 1277.

POCKET TELESCOPES.

No.	Article	Each. £	s.	d.	Each. £	s.	d.
1273	**Perspective Glasses,** with mahogany or japanned body, and one, two, or three draws . . 1s. 6d., 2s. 6d.	0	3	6	0	7	6
1274	**Pocket Telescopes,** two or three draws, with **Achromatic** object glass, Mahogany or Covered body (figs. 1274) .	0	10	6	0	12	6
1275	Ditto ditto, with **Sun Shade**				0	16	0

FIG. 1274.

FIG. 1274*.

FIG. 1274**.

No.	Article	£	s.	d.	£	s.	d.
1276	**Achromatic Telescopes,** with Leather Case and Sling Strap	1	5	0	1	10	0
1277	Ditto ditto, with Screw and Jointed Clip (fig. 1277) .				1	18	0
1278	**Pocket Rifle Telescope, Achromatic,** one draw, body covered with leather, with light sling, small portable and very powerful, to show Bullet marks at 300 to 500 yards	1	10	0	2	2	0
1279	**Pocket Achromatic Telescope—** 3 draws 24-inch, $1\frac{3}{8}$-inch Object Lens . . .				1	16	0
1280	Ditto, with sun-shade	1	18	0	2	2	0
1281	**Pocket Achromatic Telescope—** 3 draws 30-in., $1\frac{5}{8}$-inch Object Lens				2	10	0

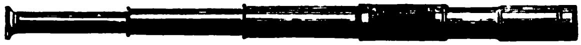


FIG. 1282.

No.	Description	Each. £	s.	d.	Each. £	s.	d.
1282	**Pocket Achromatic Telescopes,** with mahogany or rosewood body (fig. 1282):— Two, three, or four draw Brass Telescopes, with Lenses of the VERY FINEST QUALITY AND BEST MOUNTING—						
	12-inch				1	15	0
	18-inch ditto ditto				2	10	0
	24-inch ditto ditto				3	10	0
	30-inch ditto ditto	4	4	0	5	5	0
	36-inch ditto 4-draw, Extra Large Object Lens				7	10	0
1283	**Pocket Achromatic Telescope—solid German Silver Mountings, with Sun Shade, 24-inch three draw, best quality** (fig. 1282)				4	10	0
1284	Ditto ditto 30-inch				5	10	0
1285	**Pancratic Eye Tubes** (Dr. Kitchener's), to above extra.	0	12	6	1	1	0

1283 and 1284 are very suitable for Rifle Prizes, especially if fitted with Pancratic Eye Tubes.

No.	Description	£	s.	d.
1286	**Solid Leather Cases and Sling Straps** for any of above, from each extra	0	10	6

FIG. 1287.

No.	Description	£	s.	d.
1287	**12-inch Pocket Military Reconnoitreing Telescopes,** best quality, six draws, very portable, brass tubes .	1	10	0
	Ditto ditto German Silver tubes (fig. 1287) .	2	2	0
	18-in. ditto six-draw Brass tubes	2	10	0
	24-in. ditto seven-draw ditto	3	10	0
	30-in. ditto eight-draw ditto	4	10	0

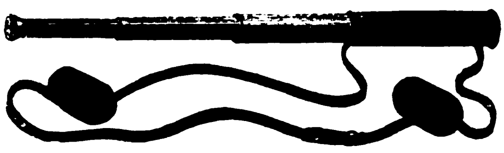


FIG. 1288.

1288 **Negretti and Zambra's Improved Achromatic Military Reconnoitreing or Deer-Stalking Telescope,** two or three draws, with Pancratic Eye-Tubes, with Sun Shade, bronzed tubes, and mounted in strong leather body or case, with sling strap (fig. 1288):—

Description	£	s.	d.	£	s.	d.
No. 1				3	3	0
No. 2	4	4	0	5	5	0
No. 3				6	6	0

The lenses of these telescopes are of the very highest quality, of great magnifying power, combined with brilliant definition and large field of view; the mountings of strong material, and best workmanship. These telescopes can be confidently recommended by Messrs. N. and Z. for Military purposes, Yatching, Deer-stalking, or for General Service.

No.	Description	£	s.	d.	£	s.	d.
1289	**Aluminium Telescope,** 3 draws, 18 inches, large Object Lens, body covered with leather, Sling Strap . .	8	8	0	10	10	0

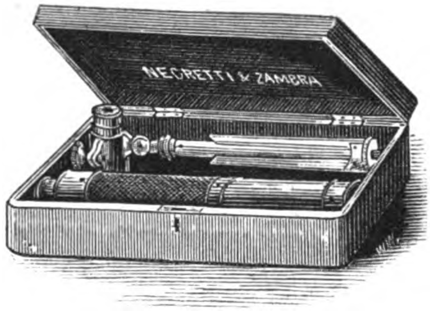


FIG. 1290.

1290 **Negretti and Zambra's Travellers' Telescope,** consists of a highly finished **Portable Telescope** with folding **Table Stand** (fig. 1290).

It is fitted with one **Terrestrial or Day Eye Piece** of high magnifying power and brilliant definition, and one **Astronomical or Night Eye Piece** of sufficient power to exhibit all the phenomena of the Planets and divide the more easily resolved of the double stars.

The whole instrument is compactly arranged in a mahogany box with lock and key, forming one of the most useful and convenient telescopes for Tourists or Sea Coast visitors. These Telescopes can be used without the stand as an ordinary *pocket* telescope.

Price, complete in box £7 7s., £8 8s., £10 10s.

MARINE TELESCOPES.

FIG. 1292.

		Each. £ s. d.	Each. £ s. d.
1291	**Marine or Day and Night Achromatic Telescopes,** yielding a large field and full body of light, adapted for Coast Service . . . . . 21s., 30s., 40s.	2 10 0	3 3 0
1292	**Day or Night Achromatic Pilot Telescopes,** with one, two, or three draws (fig. 1292)	2 2 0	2 10 0

FIG. 1293.

1293	**Pilot Telescopes,** One draw with Shade Tube (fig. 1293)	3 3 0	4 4 0
1294	**Erect Night Telescope,** with one draw and Shade Tube, Object Lens of large diameter and best quality .	5 5 0	6 6 0
1295	**Large Inverting Night Telescopes**		5 5 0

FIG. 1296*.

		Each. £ s. d.	Each. £ s. d.
1296	**Navy Telescopes, Straight or Taper Body,** as figs. 1293 or 1299°, but with plain slide adjustment covered with leather, one draw, with or without Spray or Sun Shade:		
	18-inch	2 2 0	2 10 0
	24-inch	3 10 0	4 10 0
	24-inch large Object Lens		5 12 6
	30-inch		5 5 0
	30-inch large Object Lens		5 10 0
	36-inch		7 10 0
	36-inch large Object Lens		8 10 0

1297 **Deck Telescopes,** one draw with Spray Shade. as fig. 1293.

No. of Draws.	Diameter of Object Glass.	Body covered with leather.	or Mahogany
1	1½-inch	£1 16 0	£2 2 0
1	1¾-inch	2 10 0	3 3 0
1	2-inch	3 10 0	4 10 0

1297* **Deck Telescopes,** large sizes of above with Rackwork and Sliding adjustment (fig. 1296*) £5 10 0 £7 10 0 8 10 0 10 10 0

FIG. 1297.

1298	**Midshipman's Telescope,** 18-inch Brass taper body, covered with leather, and Navy Signals inserted, sling strap (fig. 1297)	1 16 0	2 2 0
1299	Ditto ditto, Regulation pattern, German Silver, with Navy Signals, Sun Shade, and sling strap		3 3 0
1300	**Marryat's Code of Signals** fitted to Telescopes		0 10 0
1301	**Navy Code of Signals** to ditto		0 10 6
1302	**Straps and Slings** to ditto		0 10 6
1303	**Mariners' Compass, with Bar Needle or Floating Card** fitted to cap of Telescopes, to order from		0 18 0

1304 **Negretti and Zambra's Binocular Telescopes.** These instruments consist of a pair of twin telescopes, made exactly the same in the optical arrangement, and the tubes conveniently placed to allow of both eyes being used; a Rackwork or adjusting Screw is fitted between the tubes, moving both eye-pieces at one time, enabling the user to adjust the telescope for perfect vision with the greatest facility. The **Binocular Telescopes** little exceed the ordinary race glasses in size, but far surpass them in magnifying power and range; with leather case and strap (fig. 1304) . £8 8 0 10 10 0

FIG. 1304.

FIG. 1305.

NEGRETTI AND ZAMBRA'S NEW YACHTING AND DEER STALKING BINOCULAR TELESCOPES.

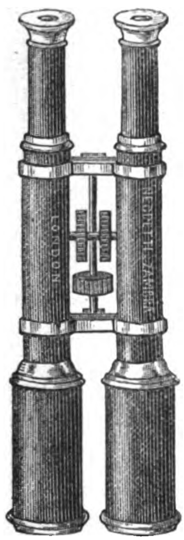


FIG. 1305.

In these instruments two great difficulties have been overcome; namely, the Contraction of Field and Loss of Light, so conspicuous in Glasses of the Old Pattern, and which precluded their use in dull or hazy weather.

These new Binoculars are free from those defects, and from the adjustments are suited to every sight and width of eyes.

The Field is large and clear, with an abundance of Light, while the magnifying Power is *much greater* than that of any Binocular Glass yet produced.

By a new adjustment, the circles of the two fields are made to coincide exactly, so that all strain is taken from the eyes in looking through them, while the breadth of the Field enables the observer to "pick up" an object at once.

These points recommend the new Binoculars for Yachting, Deer-Stalking, or for general Field use.

The New Binocular Telescope (fig. 1305).			Each. £	s.	d.
No. 1 in Bronzed Metal, with	Solid Leather Case and Strap		8	8	0
No. 2 in Bronzed Metal,	Ditto	ditto	10	10	0
No. 3 in Bronzed Metal,	Ditto	ditto	12	12	0
No. 1 in Aluminium,	Ditto	ditto	13	13	0
No. 2 in Aluminium,	Ditto	ditto	17	17	0
No. 3 in Aluminium,	Ditto	ditto	20	0	0

FIG. 1306.

1306 **Signal Station or Target Practice Telescopes,** for telegraphic and look-out purposes, or for distinguishing bullet or shot marks on targets at the longest ranges, with one draw, the body covered with mahogany, and **Rackwork** and Sliding adjustment to eye-piece (fig. 1306):

Diameter of Object Glasses. . .	2 in.	2¼ in.	2½ n.	2¾ in.	3 in.
Price	75s.	90s.	110s.	130s.	168s.

Larger sizes of above at £10 10s.; £12 12s.; £16 16s.

FIG. 1308.

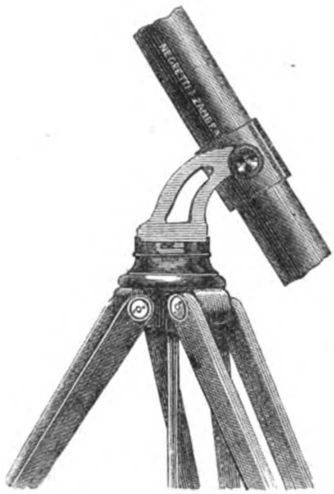


FIG. 1309*.

FIG. 1309.

		Each. £ s. d.	Each. £ s. d.
1307	**Portable Tripod Stands for Telescopes, of Wood,** with Brass Bolts and Nuts	1 12 6	1 16 0
1308	Ditto ditto with Vertical and Horizontal adjustments (fig. 1308)		2 10 0
1309	Ditto ditto Brass head, with jointed Clip, or Cradle Telescope-holder, mahogany legs (fig. 1309) . . .	3 3 0	4 10 0
1309°	**Improved Alt-Azimuth Stand** (fig. 1309*), for Astronomical Telescopes, well suited for Telescopes, Nos. 1313 and 1314; Strong Metal Mountings, very rigid, and conveniently portable	12 0 0	15 0 0

Captains' or Pilots' Binocular Night or Look-out Glasses (see pages 272, 273).

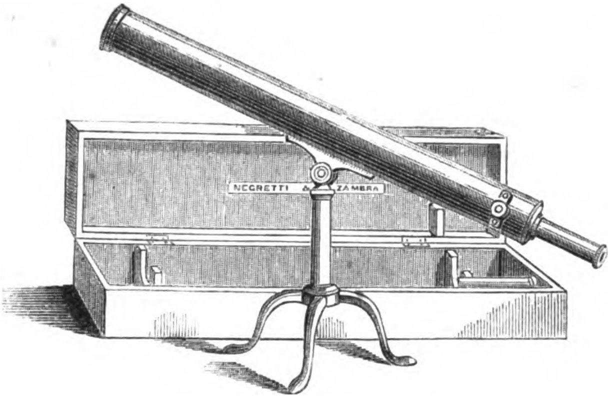


FIG. 1310.

1310 **Negretti and Zambra's "Universal" Telescope** (fig. 1310).

MESSRS. NEGRETTI AND ZAMBRA, in view of the increasing demand for Astronomical Telescopes of moderate price, have constructed one that, while it accomplishes effectually all required in the study of the heavenly bodies, is equally useful as a **Telescope** for **Terrestrial Objects,** or for marking in **Rifle Practice.** The "Universal" is furnished with an Achromatic Object Glass, three inches diameter, with an Astronomical Eye-piece, magnifying 140 diameters, and Terrestrial Eye-piece, magnifying 60 diameters. It will show Jupiter's moons, Saturn's ring and moons, and resolve some of the double stars; while for **Terrestrial Objects** it will define well at a distance of ten to fifteen miles, and will show a bullet mark on a Target at the longest ranges.

For astronomical purposes, an **Extra Eye-piece** can be added, magnifying 200 diameters. The cost is 12s. 6d., and it can be applied at any time.

Messrs. NEGRETTI AND ZAMBRA have also arranged Telescopes similar to the above, but of very much better finish, price £8 8s., £10 10s.

Firm Tripod Garden Stands for above, £3 10s. to £4 10s.; see also previous page.

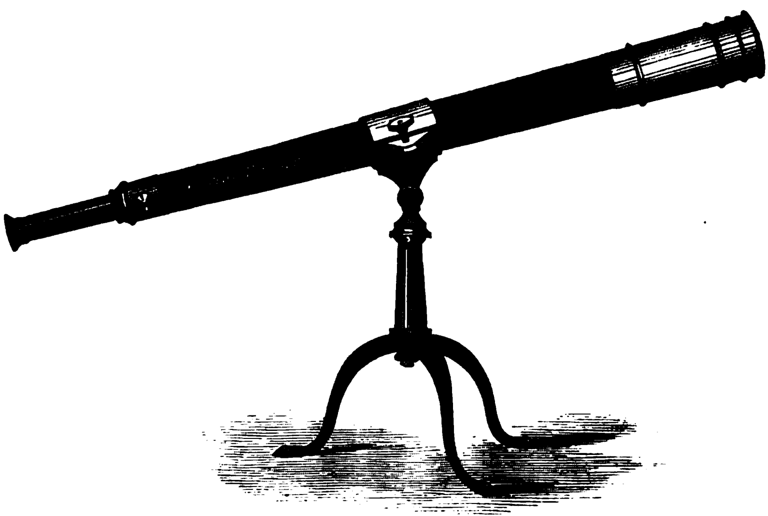


FIG. 1311.

NEGRETTI AND ZAMBRA'S SIGNAL STATION OR TELEGRAPH LOOK-OUT TELESCOPE.

1311 **Negretti and Zambra's Rifle or Target Practice, Signal Station, Light-house, or Telegraph Look-out Telescope,** having Rackwork and Sliding Adjustments to the Eye-tube, mounted on a strong, steady Tripod Table Stand, with universal movements and hinged Clip for holding the Telescope, so contrived that when not in use the Telescope can be quickly removed from its Stand, and both be securely packed away in the stout hinged case supplied with the instrument (fig 1311).

Size.	Diameter of Object Glass.	Each. £	s.	d.
30 in.	2 in.	8	10	0
36 in.	2¼ in.	9	10	0
40 in.	2½ in.	10	10	0
48 in.	3 in.	12	12	0

These Telescopes have sufficient magnifying and defining power for distinguishing **Bullet** or **Shot Marks on a Target** at the longest ranges. Ships' signals distinguished at equally long distances. Well suited for Coastguard Stations or as a Sea-side look-out glass.

Tripod Out-of-Door Stands suited for above, see page 281.

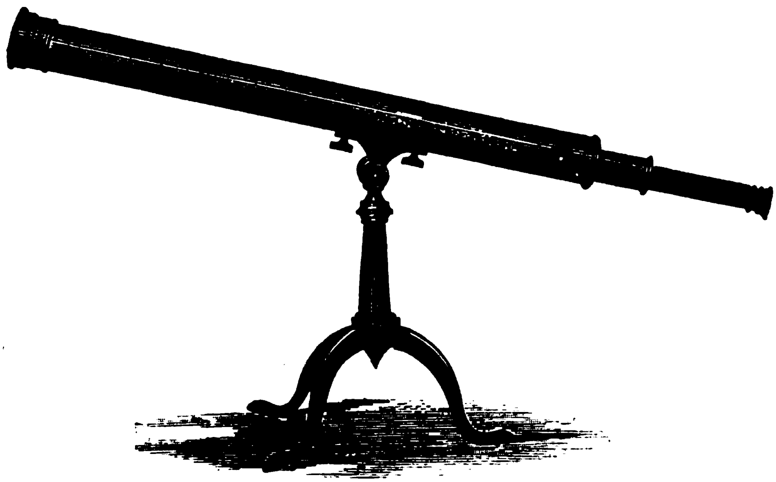


FIG. 1312.

ASTRONOMICAL TELESCOPES.

1312 **Achromatic Astronomical and Terrestrial Telescope** (fig. 1312), Bright Brass body, **Sliding** and **Rackwork** movement to eye-piece tube, mounted on a pillar and claw brass Table-stand, having horizontal and vertical motion, in a strong box, with lock and key.

	EYE-PIECES.		POWER.				
Size of Object Lens.	Terrestrial.	Astronomical.	With Terrestrial Eye-piece.	With Astronomical Eye-piece.	Each. £	s.	d.
2 in.	1	1	20 times	45 times	10	10	0
2¼ in.	1	1	30 „	55 „	11	11	0
2½ in.	1	1	40 „	70 „	14	14	0

FIG. 1313.

1313 **Achromatic Astronomical Telescope,** on handsome **Brass** Pillar and Claw Table Stand, with Sliding and Rackwork adjustments to Telescope, and Achromatic Finder.

Elevating and Steadying Rod (fig. 1313). In Solid Mahogany Box, Polished, with Lock and Key.

	EYE-PIECES.		POWER.			Each.		
Size of Object Lens.	Terrestrial.	Astronomical.	With Terrestrial Eye-piece.	With Astronomical Eye-piece.		£	s.	d
3 in.	1	2	45 times	65 times	80 times	25	0	0
3¼ in.	1	2	50 ,,	75 ,,	90 ,,	30	0	0
3½ in.	1	2	60 ,,	80 ,,	95 ,,	35	0	0

1314 **Achromatic Astronomical Telescope,** the same as No. 1313, with Tangent Screw, and Hook's Universal Joint for horizontal adjustment, and extra steadying rods to Telescope (fig. 1314). In Solid Mahogany Box, Polished, with Lock and Key.

	EYE-PIECES.		POWER.			Each.		
Size of Object Lens.	Terrestrial.	Astronomical.	With Terrestrial Eye-piece.	With Astronomical Eye-piece.		£	s.	d.
3¼ in.	1	2	50 times	75 times	90 times	36	0	0
3½ in.	1	2	55 ,,	80 ,,	95 ,,	42	0	0
3¾ in.	1	2	60 ,,	85 ,,	105 ,,	48	0	0
4 in.	1	2	70 ,,	90 ,,	110 ,,	66	0	0

1315 **Tripod Garden Stands,** for above Telescopes, of polished Mahogany, with strong Brass mountings both for vertical and horizontal movements. See also page 281 5 5 0 7 7 0

FIG. 1314,

		Each. £ s. d.	Each. £ s. d.
1316	**Astronomical Telescope,** having bright **Brass Body,** with 3-inch Object Lens, one terrestrial and two astronomical eye-pieces, rack and sliding adjustment to eye-tube and **Achromatic Finder,** mounted on a firm **Tripod Stand,** having vertical steadying rod, with convenient adjustments for Altitude and Azimuth. The Telescope and eye-pieces are arranged so as to pack in a stout box, with lock and key . .		24 10 0
1317	**Astronomical Telescope,** 3¾-inch Object Lenses, one terrestrial and three astronomical eye-pieces, sliding and rackwork adjustment to telescope, achromatic finder, *vertical steadying rod, and tangent screw adjustment to horizontal motion,* &c., &c., as fig. 1317. The telescope and eye-pieces to pack in stout case, with lock and key, complete		42 0 0
1318	**Telescope Stand,** with three double wooden legs with brass and iron fittings, very firm and steady, giving the horizontal and vertical motions easily; suited for **large Telescopes**		12 12 0
1319	Ditto ditto with *vertical rack, steadying rod,* and *horizontal tangent rack,* complete (as in fig. 1317) .		15 15 0

* 1318 and 1319 Stands can be arranged for the Telescope 1216 to 1221.

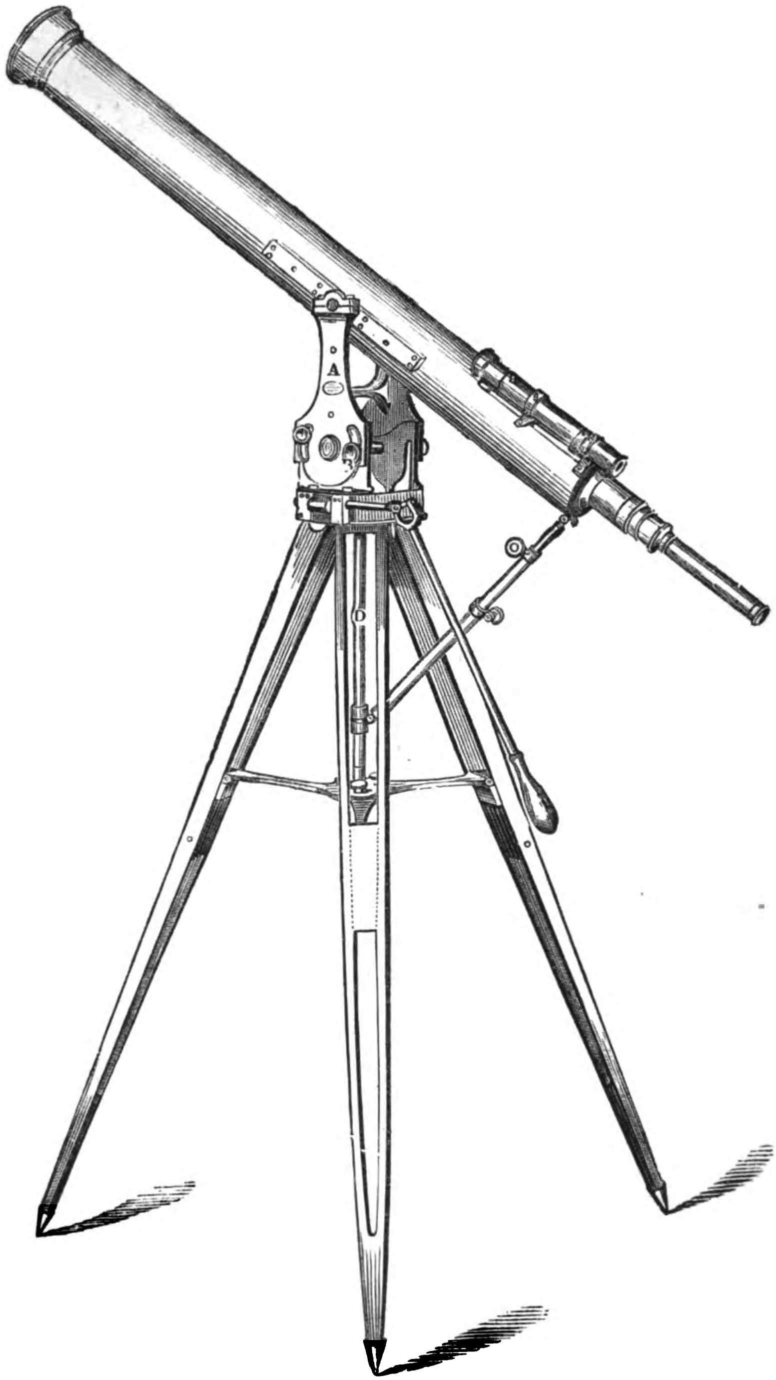


FIG. 1317.

1320 **Negretti and Zambra's Educational Astronomical Telescope,** No. 1317, **with Vertical and Horizontal screw adjustments, Steadying Rod, &c.**

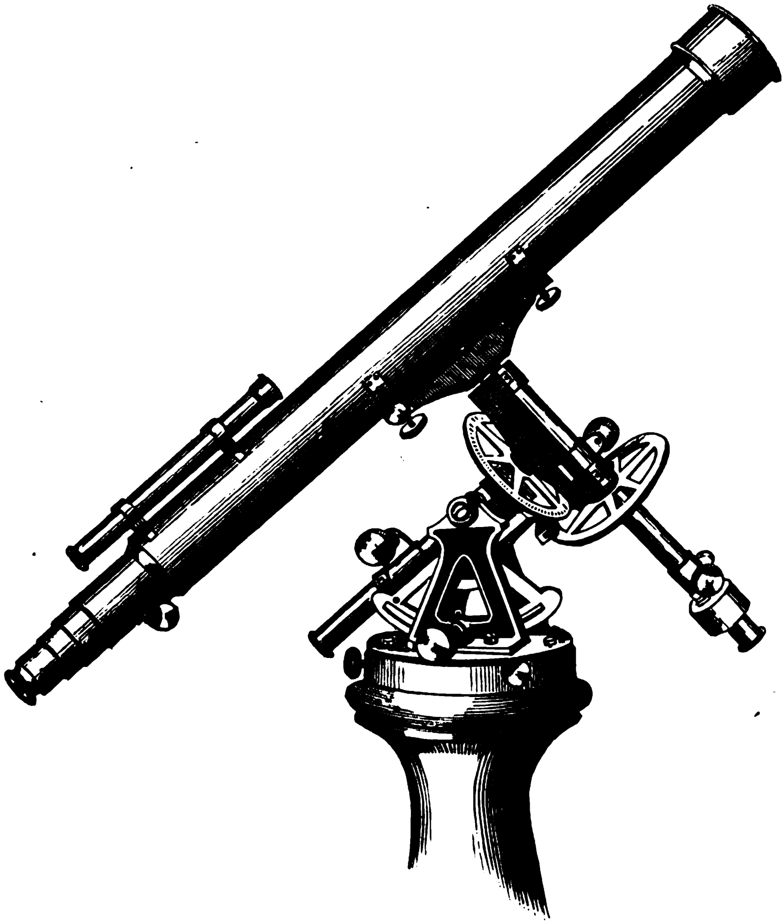


FIG. 1324.

		£	s.	d.
		Each.		
1321	**Equatorial Telescopes,** Portable "Universal," 3½-inch Object Lens, one Terrestrial eye-piece, one solar eye-piece, four Celestial eye-pieces, illuminating apparatus, declination and hour circles divided upon silver, with verniers, tangent screw adjustments, &c., &c., complete, with strong wood tripod stand, packed in two stout cases	70	0	0
1322	Ditto ditto ditto Object lens 3¾ inches diameter 5 feet focus	80	0	0
1323	Ditto ditto ditto ditto 4 inches ditto ditto .	88	0	0
1324	**Equatorial Telescopes,** for **Observatories,** 5 feet focus, Object lens 4 inches diameter, rack adjustments, achromatic finder, six astronomical eye-pieces, diagonal, transit, and solar eye-pieces, illuminating apparatus, position micrometer with double parallel wires and four eye-pieces; the hour and declination circles divided on silver with verniers, microscopes, tangent screw adjustments, clockwork motion, equatorial and for declination and ascension, &c., complete, on strong iron pillar, with flange and bolts in the middle for azimuth adjustment (fig. 1324)	130	0	0

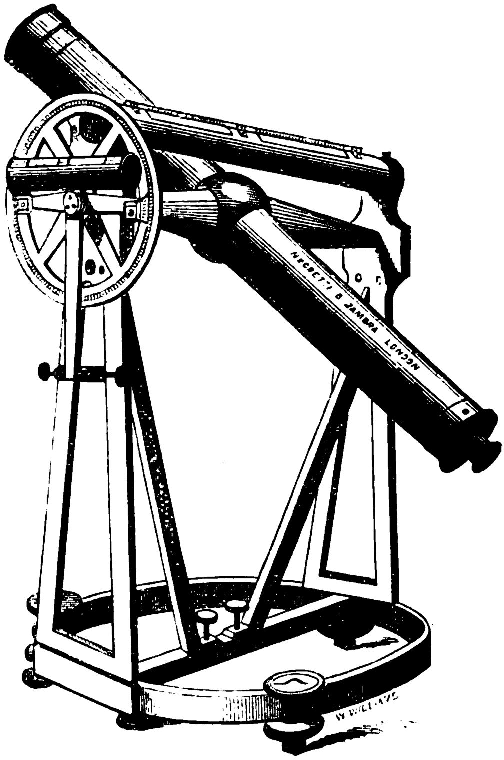


FIG. 1328.

No.		Each. £ s. d.	Each. £ s. d.
1325	**Equatorial Telescopes,** as No. 1324, with the most recently improved adjustments (fig. 1324)		
	Object lens . 4½ in. 5 in. 6 in diameter.		
	Focal length . 5 ft. 8 in. 6 ft. 4 in. 7 ft. 6 in.		
	Price . . £200 £250 £350		
1326	**Equatorial Telescope Stands** . . . . from		42 0 0
	Larger Instruments to order.		
1327	**Two-feet Transit Instruments,** on portable Iron Stand, with engine divided circle, spirit levels, and tangent screw adjustment		27 0 0
1328	**Transit Instrument,** Two-and-a-half feet, with 2¾-inch aperture Telescope improved make (fig. 1328) . .		48 0 0
1329	**Transit Instrument,** Two-and-a-half feet, with two setting circles and Brass stand		55 0 0
1330	**Transit Instrument,** Thirty-six inch ditto, with ditto		70 0 0
1331	**12-inch improved Altitude and Azimuth Instrument,** divided on silver, the azimuth circle reading by verniers, and the altitude by micrometers . from		108 0 0
1332	**Telescopic Eye-pieces** (Huyghenian or Ramsden's) .		0 16 0
1333	**Telescopic Eye-pieces** High powers Ditto ditto £1 1 0	2 2 0	2 5 0

		Each. £ s. d.	Each. £ s. d.
1334	**Telescopic Eye-pieces** (Huyghenian or Ramsden's)	0 16 0	1 5 0
1334*	Ditto ditto Very high Powers	2 2 0	2 5 0
1334†	Ditto ditto Solar Diagonal		4 10 0
1335	Ditto ditto Terrestrial or Day Erect Eye-piece .		1 14 0
1336	Ditto ditto Comet		1 10 0
1337	Ditto ditto Transit for use with Equatorials .	1 10 0 to	3 3 0
1338	Ditto ditto Aplanatic, extra large field . .		2 6 0
1339	Ditto ditto Orthoscopic (Kelner's), to order .		2 5 0
1340	**Annular Micrometer**, with Eye-piece		1 10 0
1341	**Micrometers, Glass**, and divided to parts of an Inch or Millimetres		0 15 0
1342	**Position Micrometer** of the best form	12 12 0	15 0 0
1343	**Illuminating Apparatus**		12 12 0

1344 **Telescope Object Glasses, Achromatic,** best quality :—

Diameter	1¼ in.	1-7/16	1⅝ in.	2 in.	2¼ in.	2⅝ in.	2-11/16	3 in.	3¼ in.	3⅝ in.
Focus, about	10 in.	15 in.	20 in.	27 in.	34 in.	34 in.	40 in.	46 in.	52 in.	52 in.
Price	10/6	15/	18/	20/	30/.	42/.	63/.	105/.	160/.	300/.

1345 **Small Equatorial Star Finder,** for the use of Students. 4-inch divided circles; achromatic telescope, with a 1-inch and ⅛th object lens. With this instrument, any star or planet, can be found with facility, and many important facts in astronomical science demonstrated . . . £12 12 0

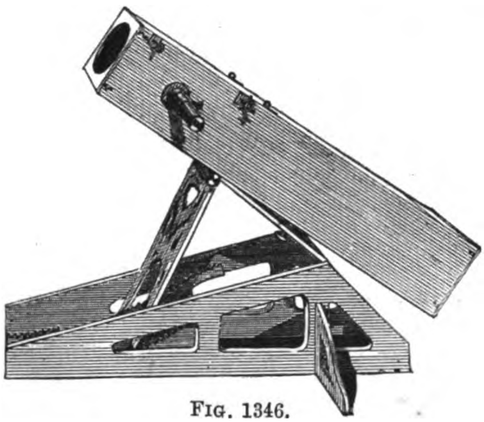


FIG. 1346.

1346 **Foucault's Reflecting Telescope,** for Terrestrial or Astronomical observations. The improvements of this telescope are principally in the use of a **Glass** Speculum coated upon the **surface** with pure Silver. The eye-piece is an achromatic microscopic arrangement of lenses mounted on the side of the telescope, the image being received from the large speculum by a prism, and the reflected image examined by the microscope eye-piece, which is fitted with rack-work adjustment. With these arrangements, high powers can be used, and large field of view, combined with light, obtained. Mounted on a table stand, with simple adjustments (fig. 1346) £18 18 0

1347 **Reflecting Telescope Astronomical, on Improved Alt-Azimuth Stand,** having 6½-inch **Silvered** Glass Speculum, 5-feet or 6½-feet focus, with Two Eye-pieces £28 0 0

1348 **Reflecting Telescope on Patent Equatorial Stand,** 8½-inch Speculum, 6½-feet focus, with Two Eye-pieces, and one Achromatic Eye-piece £45 0 0

1349 **Larger** ditto ditto. £60, £80, £105

With simple instructions for re-silvering the speculum.

Gregorian or Newtonian Reflecting Telescopes constructed to order.

MICROSCOPES.

HISTORY OF THE MICROSCOPE.

The History of the Microscope, like that of many other valuable inventions has been veiled in considerable obscurity by the lapse of time. It seems pretty certain that the ancients were not unacquainted with the microscope, in at least one form, if we are to give credence to a passage in Seneca. "Letters," says he, "though minute and obscure, appear larger and clearer through a glass bubble filled with water." Amongst the moderns (for during the Middle Ages it appears to have been entirely lost) the honour of its discovery has been claimed by many individuals. By Huygens, the celebrated Dutch mathematician, its invention is attributed to one of his countrymen, named Drebell. Microscopes were constructed by him in the year 1521, that is to say shortly after the invention of the telescope. It is asserted by Borrelli, that Jansen, the reputed contriver of the telescope, was its inventor, and that he presented some such instruments to Prince Maurice, and Albert, Archduke of Austria. These instruments were six feet in length, and consisted of a tube of gilt copper, supported by thin brass pillars in the shape of dolphins, on a base of ebony, which was adapted to hold the objects to be examined. Of the internal construction of this microscope we have no account, though there is reason to believe that it was nothing more than a telescope converted into a microscope. Viviani, an Italian mathematician, also expressly informs us, in his *Life of Galileo*, that this great man was led to the construction of the microscope from that of the telescope; and in the year 1612, he actually sent a microscope to Sigismund, King of Poland. In the year 1618, Fontana, a Neapolitan, made a microscope of two double convex lenses, and wrote an account of it in a work which he published in 1646.

In No. 42 of the *Philosophical Transactions* of the Royal Society for 1668 will be found an account of a microscope made by Eustachio Divini at Rome, which consisted of two plano-convex lenses, so placed as to touch each other in the centre. It is described as having been 16 inches long, the eye-glass nearly as broad as the palm of the hand, and the tube in which it was mounted about 4 or 5 inches diameter. It was adjusted at four different lengths; in the first, which was the least, it showed objects 41 times larger than when viewed by the naked eye; in the second, 90 times; in the third, 111 times; and in the fourth, 143 times.

For a long period, however, curious as the fact may now appear, the single microscope was that generally in use, and the compound instrument was considered as a mere philosophical toy, owing to the distance which the light had to traverse and the consequent increase of the chromatic and spherical aberrations. Indeed, so impossible did it appear to overcome this great difficulty, that philosophers of no less eminence than M. Biot and Dr. Wollaston predicted that the compound would never rival the simple microscope, and that the idea of rendering its object-glass achromatic was hopeless. Nor can these opinions be wondered at, when we consider how many years the achromatic telescope had existed without any attempt to apply its principles to the compound microscope. When we consider the smallness of the pencil required by the microscope, and the enormous increase of difficulty attending every enlargement of the pencil; when we consider further, that these difficulties had to be contended with, and removed, by operations on portions of glass so small that they were themselves almost microscopic objects, we shall not be surprised, that even a cautious philosopher and able manipulator like Dr. Wollaston should prescribe limits to its improvement.

Fortunately, however, for science, and especially for the departments of animal and vegetable physiology, these predictions have been shown to be unfounded. A few years sufficed to elevate the compound microscope from the condition we have described to that of being the most important instrument ever bestowed by art upon the investigator of nature. It now holds a very high rank amongst philosophical instruments; while the transcendent beauties of form, colour, and organisation which it reveals to us in the minute works of nature render it subservient to the most delightful and instructive pursuits. To these claims on our attention it appears likely to add a third of still higher importance. The microscopic examination of the blood and human organic structures, will, in all probability, still more than ever it has yet done, afford satisfactory and conclusive evidence regarding the nature and seat of disease, than any hitherto appealed to; and will, of consequence, lead to similar certainty in the choice and application of remedies. Soon after the year 1820, a series of experiments was begun in France, by M. Selligues, which were followed up by Fraunhofer, at Munich, by Amici at Modena, by Chevalier at Paris, and by Mr. Tulley, of London. In 1824, the last-named artist, without knowing what had been done on the continent, made an attempt to construct an achromatic object-glass for a compound microscope, and produced one of 9-10ths of an inch focal length, composed of three lenses, and transmitting a pencil of eighteen degrees. This was the first that had been made in England. While these practical investigations were in progress, the subject of achromatism engaged the attention of some of the most profound mathematicians in England. Sir John Herschel, Professor Airy, Professor Barlow, Mr. Coddington, and others, contributed largely to the theoretical examination of the subject; and though the results of their labours were not immediately applicable to the microscope, they essentially promoted its improvement. Between this period and the year 1829, Mr. Joseph Jackson Lister had directed his attention more particularly to this subject, and he was led to the discovery of certain properties in achromatic combinations which had been before unobserved. A paper on the subject was sent by him to, and published by, the Royal Society.* To the practical optician the investigations and results of Mr. Lister proved to be of the highest value; and the progress of improvement was in consequence extremely rapid, and since that period every year has brought this instrument nearer to perfection.†

"No one," says a writer in the *Popular Science Review*, "can fail to be struck with the beautiful appearance of objects viewed under the Binocular Microscope. Its chief application is to such objects as require *low powers* and can be seen by reflected light, when the wonderful relief and solidity of the bodies under observation astonish and delight even the adept. Foraminafera, always beautiful, have their beauties increased tenfold; vegetable structures, pollen, and a thousand other things are seen in their true lights; and even diatoms, we may predict, will receive elucidation, as to the vexed question of the convexity or concavity of their infinitely minute markings. The importance of the Binocular principle is especially apparent when applied to Anatomical investigations. Prepared microscopic injections exhibit under the ordinary microscope a mass of interlacing vessels, whose relation being all on the same plane, it is not easy to make out with any degree of satisfaction. But placed under the Binocular they at once assume their relative position. Instead of a flat band of vessels we now see layer above layer of tissue; deeper vessels anastomosing with those more superficial; the larger vessels sending branches, some forward and some; backward, and the whole injection assumes its *natural* appearance, instead of being only like a *picture*."

* Philosophical Transactions, 1829.

† To those who may be desirous of studying this question more in detail, we would recommend for consultation Brewster's *Treatise on Optics*; Article *Microscope*, in the *Penny Cyclopædia*, and the same Article in the *Edinburgh Cyclopædia* and the *Encyclopædia Britannica*, and the *Journal of the Microscopical Society*.

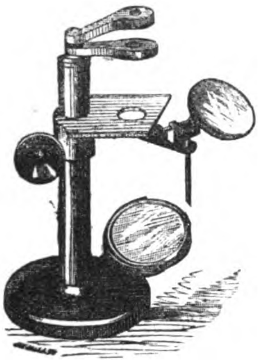


FIG. 1351.

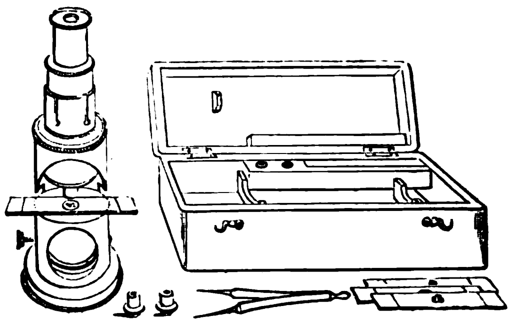


FIG. 1353.

SIMPLE AND COMPOUND MICROSCOPES.

No.	Description	Each. £ s. d.	Each. £ s. d.
1350	**Botanic or Dissecting Microscope,** Simple Lenses, a variety of forms, with pillar to screw into the top of the box containing the apparatus . 11s. 6d., 16s.	0 17 0	1 10 0
1351	Ditto ditto, with Rackwork adjustment and apparatus, in Mahogany Box (fig. 1351)	1 5 0	1 10 0

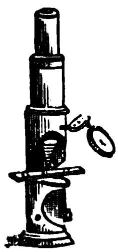


FIG. 1354.

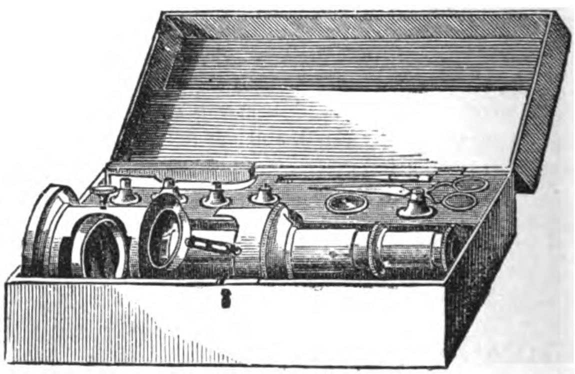


FIG. 1355.

No.	Description	Each. £ s. d.	Each. £ s. d.
1352	**Compound Microscope,** with sliding tube adjustment, mirror, eye-piece, and magnifying power, forceps, and one microscopic object; in a Mahogany hinged box .		0 10 0
1353	**Compound Microscope,** with three magnifying powers and two objects and stage glass for holding water, &c., in Mahogany box (fig. 1353)	0 16 0	0 18 0
1354	**Compound Microscope,** with three magnifying powers, a mounted lens for condensing the light on opaque objects; in Mahogany box (fig. 1354)	1 1 0	2 2 0

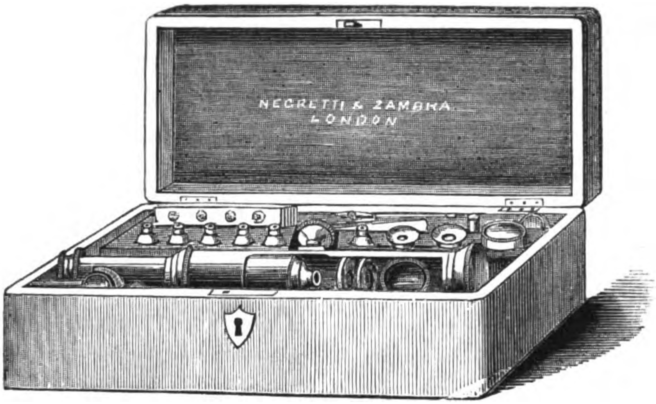


FIG. 1356.

No.	Description	Each. £ s. d.	Each. £ s. d.
1355	**Compound Microscope (Martin's),** with sliding adjustment, mirror, four powers, objects, forceps, water trough, insect box, stage plates, glass tube, &c. (fig. 1355)		2 10 0
1356	**Large Compound Microscope, Martin's Improved,** best finish, and lenses, with **Rackwork** adjustment (fig. 1356)	3 10 0	4 4 0
1357	**Dissecting or Mounting Microscope,** improved form, arranged for medical or botanical investigation. The stage plate is made of stout glass, set in a circular brass rim supported on three legs; beneath the stage is a mirror, with convenient adjustment. This Microscope is fitted with three simple powers, ½-inch, 1-inch, and 2-inch focus. Arranged in a neat Mahogany box, with brass forceps, &c. . .		2 2 0
1358	**Dissecting Microscope,** similar to No. 1357, but with Compound Body, having Rackwork adjustment (as fig. 1357), also 1-inch and ¼-inch Achromatic Powers, in Mahogany Box, with brass forceps, &c. . . .		4 4 0

ACHROMATIC MICROSCOPES.

No.	Description		
1359	**Achromatic Microscope,** on upright pillar and firm circular stand, with rackwork adjustment to body, with Achromatic powers; in Mahogany box (fig. 1359)	£3 0 0	£4 0 0
1360	**Achromatic Microscope,** with jointed pillar, and firm circular foot, rackwork adjustment to the body, sliding clamp for objects on the stage, with a set of Achromatic lenses, brass forceps, &c.; in Mahogany case (fig. 1360)		£4 10 0

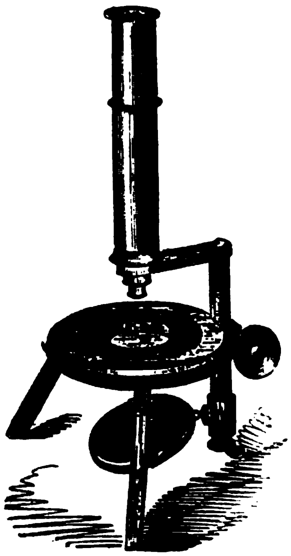


FIG. 1358.

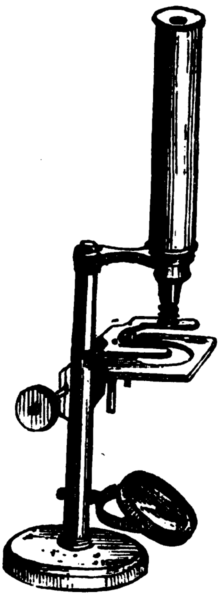


FIG. 1359.

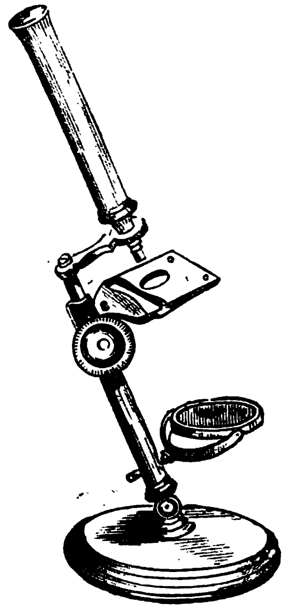


FIG. 1360.

1361 **Negretti and Zambra's No. 1. Educational Microscope,** on firm bronzed tripod stand, with trunnion joint to incline the instrument at any angle, rackwork adjustment to the body, sliding holder and diaphragm plate on the stage, brass forceps, stand condenser, two eye-pieces, and two sets of **Achromatic Powers,** in brass boxes; fitted in Mahogany cabinet, with lock and key (fig. 1361) £3 10 0

1362 **Negretti and Zambra's No. 2. Educational Microscope,** of similar form to No. 1, with Fine Adjustment and Lengthening Tube to the body, slide holder and diaphragm plate, flat and concave mirror, stand condenser, brass forceps, and 1-inch and ¼-inch **Achromatic Powers,** in brass boxes; fitted in mahogany cabinet, with lock and key (fig. 1362) . . £4 10 0

	Each. £ s. d.	Each. £ s. d.
1363 **Negretti and Zambra's No. 3. Educational Microscope,** similar to No. 2, and fitted with **Polarising** Apparatus (as fig. 1361)	5 10 0	6 10 0
1364 **Negretti and Zambra's No. 4. Student's Microscope,** similar to No. 3, with **Mechanical Stage,** having adjustments in two directions, suited for elementary instruction or amusement (fig. 1364)		8 10 0

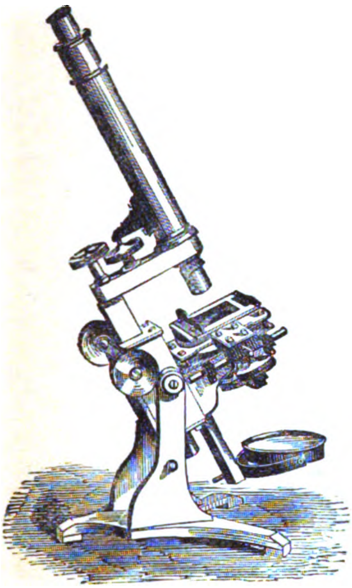


FIG. 1364.

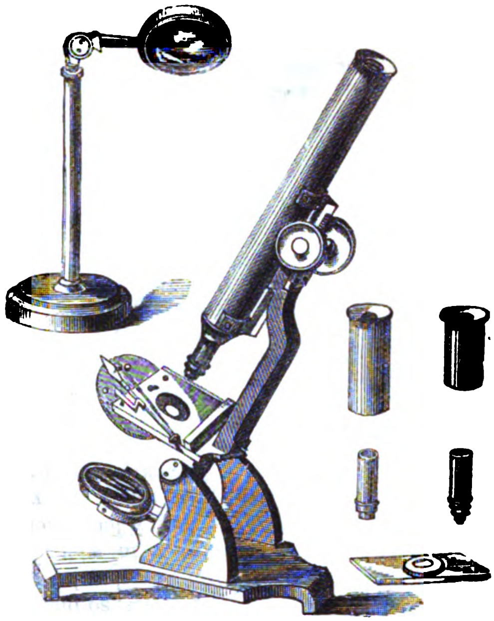


FIG. 1361.

		Each. £ s. d.
1365	**Negretti and Zambra's No. 5. Student's Achromatic Microscope**, similar to No. 4, but with **Polarising** Apparatus	10 10 0
1366	**Negretti and Zambra's No. 6. Student's Achromatic Microscope**, similar in size to No. 5, with the same adjustments, powers, &c., and the addition of Polarising Apparatus and Spotted Lens and Stage Condenser	18 18 0

1367	**Negretti and Zambra's Student's Binocular Microscope**, with convenient adjustment for width of eyes, Plain Stage, two eye-pieces, and 1-inch and ½-inch Achromatic object Lenses stand, condenser, live-box, dipping tubes brass forceps, &c.; packed in Mahogany cabinet	10 10 0
1367°	**Student's Binocular Microscope**, as No. 1367, but with extra ¼-inch Power, and Polarising Apparatus, &c.	16 16 0

The above Microscopes have been constructed to supply instruments of moderate price, but with good workmanship, and solid mechanical arrangements.

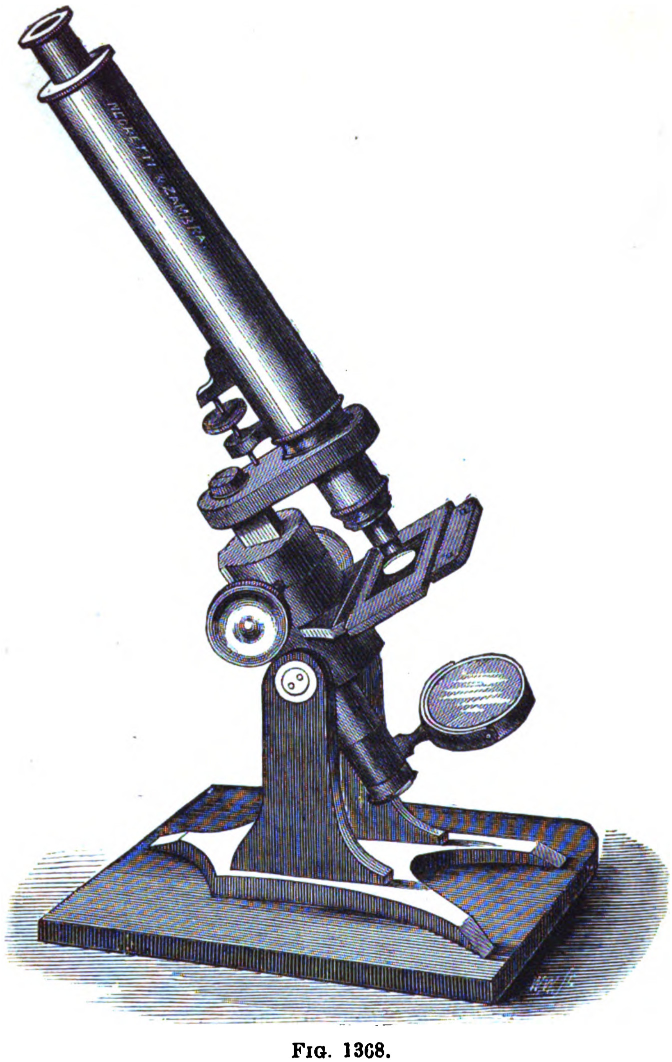


FIG. 1368.

Negretti and Zambra's Full-sized Monocular Achromatic Microscope.

1368 Mounted on a firm brass stand, Rackwork adjustment to the body, Fine adjustment for the object lens, sliding and rotating object holder, and revolving diaphragm to the stage, two eye-pieces A and B, three Best Achromatic powers or object lenses, 1-inch, $\frac{1}{2}$-inch, and $\frac{1}{4}$-inch, large condensing lens on stand, live box or animalculæ cage, stage condenser and stage forceps, plain and curved brass forceps, dipping tubes, stage glasses, &c., &c.; in solid polished Mahogany Cabinet, with lock and key £36 0 0

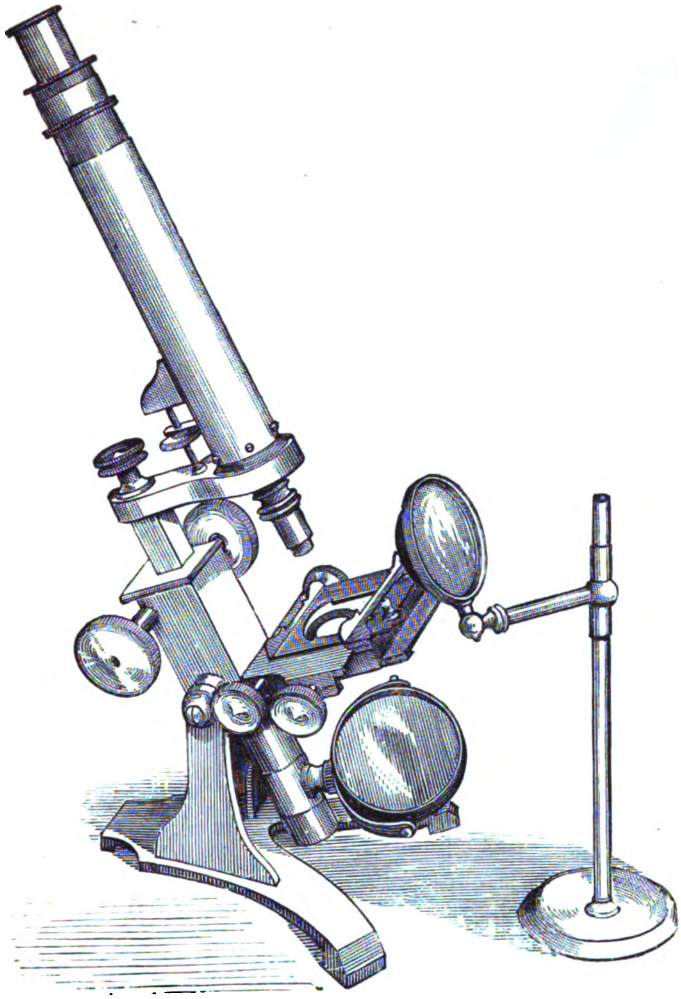


FIG. 1369.

Negretti and Zambra's best Large Size Monocular Achromatic Microscope.

1369 Very firm brass stand, with **Mechanical Stage,** having motion in rectangular directions, sliding and rotating object holder, spring clamp slide, revolving diaphragm plate for regulating the amount of light, plain and concave reflector, arranged to give an oblique pencil of light, clamping arc for fixing the instrument at any angle, coarse and fine adjustments to the body, three eye-pieces, A, B, and C, three **best** Achromatic powers, 1-inch, ½-inch, ¼-inch, in brass boxes, with adapters, **Polarising Apparatus,** selenite plates, micrometer eye-piece, camera lucida, spotted lens, stand condenser, stage ditto, two live-boxes or animalculæ cages, compressorium, straight and curved forceps, frog plate, side illuminator, fishing tubes, stage glasses, stage micrometer, &c., &c.; complete in a Solid polished Mahogany Cabinet, with lock and key £60 0 0

1369* **Binocular Body,** for above, extra 5 10 0

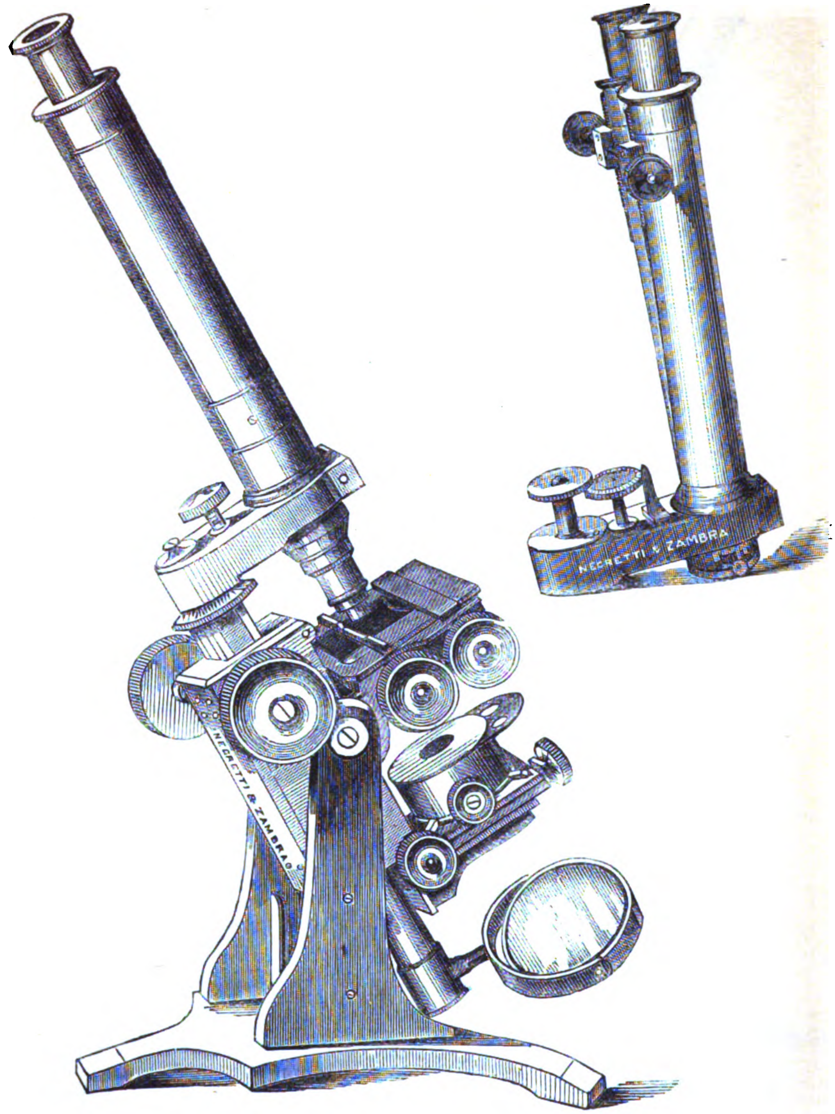


FIG. 1370.

Negretti and Zambra's Largest and Best Monocular Microscope.

1370 With separate **Binocular Body.** Complete Stage movements, Secondary or Sub-stage (fig. 1370), four eye-pieces, A, B, C, and D, 3-inch, 2-inch, $1\frac{1}{2}$-inch, 1-inch, $\frac{1}{2}$-inch, $\frac{1}{4}$-inch, $\frac{1}{6}$-inch, $\frac{1}{8}$-inch Achromatic Object Glasses, three Lieberkuhn's, large spotted lens, complete Polarising apparatus with rotatory prism and large adapter, paraboloid, dark wells, Brook's double nose-piece, compressorium, lever compressorium, large and small live cage, camera lucida, condenser on stand, stage condenser, spotted lens, side reflector, Darker's revolving selenite stage, stage forceps, straight and curved forceps, large glass trough, small ditto, two stage plates, stage micrometer, six fishing tubes in case, three moderators, revolving diaphragm, achromatic condenser, frog plate, two dissecting plates, micrometer eye-piece, achromatic ditto; in Solid polished Mahogany Cabinet for Microscope, and a flat walnut case containing the Apparatus and five dozen. Balsam Mounted choice objects £150 0 0

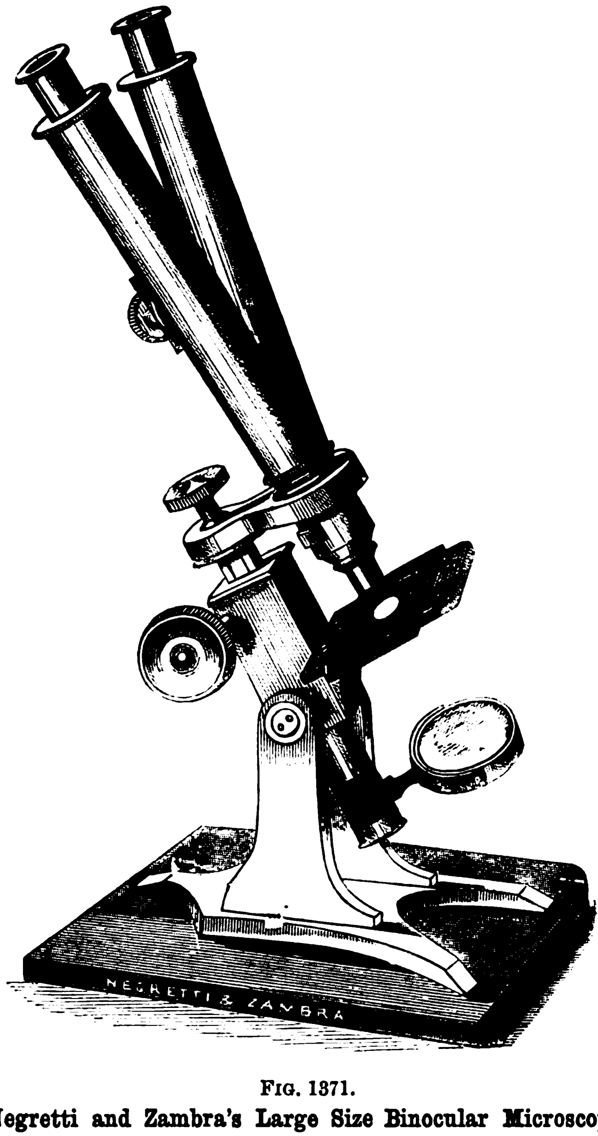


FIG. 1371.

Negretti and Zambra's Large Size Binocular Microscope.

1371 Mounted on a highly finished brass stand, with sliding and rotating object holder, Rackwork adjustments to the body, and eye-tubes, best 2-inch, 1-inch, $\frac{1}{2}$-inch, and $\frac{1}{4}$-inch Achromatic powers, two eye-pieces, stand condenser, live box, forceps, dipping tubes, stage plates, &c.; in handsome polished Mahogany Cabinet £18 18 0

1371* **Polarising Apparatus,** with Selenite Stage Plates, for above, extra Spotted Lens and Stage Condenser £3 10 0

These Binocular Microscopes have their Prisms so mounted that the instruments may be used as Monoculars.

The Stands of the Microscope Nos. 1368 to 1371 can be supplied without lenses, apparatus, or cabinets, at proportionate prices.

ENGLISH ACHROMATIC OBJECT GLASSES.

FOR MICROSCOPES.

Focal Length.	Angular Aperture.	Magnifying Power with various Eye-pieces.	Price.
		DIAMETERS.	
3-inches	12 degrees	20 to 60	£2 0 0
2-inches	15 degrees	20 to 60	3 0 0
1½-inch	20 degrees	40 to 90	3 0 0
1-inch	16 degrees	60 to 120	2 0 0
1-inch	25 degrees	60 to 120	2 10 0
½-inch	30 degrees	100 to 220	3 10 0
*½-inch	65 degrees	100 to 220	4 0 0
¼-inch	75 degrees	220 to 620	4 10 0
*¼-inch	95 degrees	220 to 620	5 5 0
[illegible]-inch	135 degrees	320 to 900	8 8 0
⅛-inch	150 degrees	620 to 1200	10 10 0

Those marked (*) have adjustments for covered and uncovered objects, and the screws are cut to the standard gauge of the London Microscopic Society.

These object Lenses are of the finest **English** manufacture, and for penetrating and defining power cannot be surpassed.

		£	s.	d.
1372	**Sets of Achromatic Object Lenses,** for Microscopes of the best **French** or **German** manufacture, combined focus, 1-inch	1	0	0
	Ditto ditto, ½-inch	1	5	0
	Ditto ditto, ¼-inch	1	10	0

For Pocket Microscopes and Hand Magnifiers see pages 256 and 257.

APPARATUS, ETC., FOR MICROSCOPES.

		Each. £ s. d.	Each. £ s. d.
1373	**Eye Pieces, Huyghenian** (figs. 1373 and 1373*)	0 10 0	0 15 0
1374	Ditto ditto Best A, B, C, and D, E, and F.	0 16 0	1 1 0
1375	Ditto, **Erecting** for Dissecting, with compound microscope	0 15 0	1 0 0
1376	**Micrometer Eye Pieces**		1 4 0
1377	**Kellner's Orthoscopic Eye-pieces,** giving larger field		1 10 0
1378	**Ross's Centreing Glass**		0 15 0
1379	**Indicator to Eye-piece**		0 6 6
1380	**Brook's Double Nose Piece,** for rapidly changing the object, Lens or power of a Microscope		1 10 0
1381	**Stand Condensers,** small (fig. 1381)	0 10 6	0 16 0
1382	Ditto ditto with **Large Lens** and convenient adjustments (fig. 1382) . 22s.	1 10 0	1 16 0
1383	**Shadbolt's Parabolic Condenser,** in brass mountings	1 14 0	2 15 0
1384	**Achromatic Condenser,** plain		2 5 0
1385	Ditto ditto **Gillet's**		7 0 0

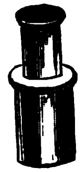


FIG. 1373.

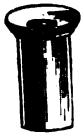


FIG. 1373*.

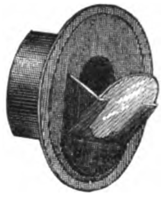


FIG. 1403.

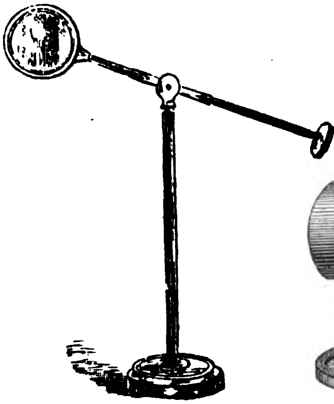


FIG. 1381.

FIG. 1402.

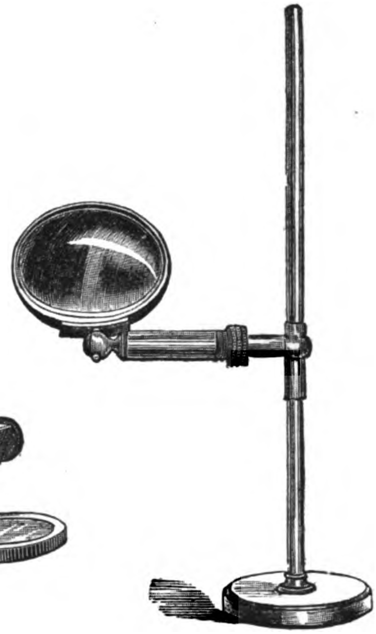
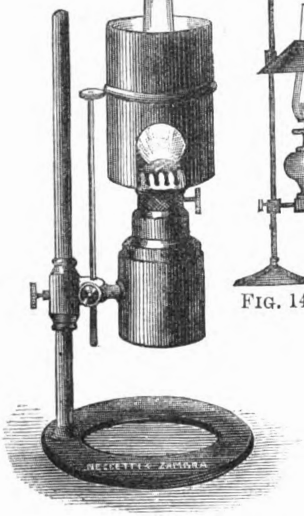


FIG. 1382.

			Each. £ s. d.	Each. £ s. d.
1386	**Kingsley's Illuminator**			3 18 0
1387	**Reade's Hemispherical Condenser**			2 2 0
1388	**Lieberkuhn, or Cup Reflector** . . .	10s. 6d.	0 16 0	1 0 0
1389	**Rectangular Prism,** for use instead of a mirror . .		1 10 0	2 10 0
1390	**Rainey's Light Modifier**			0 7 6
1391	**White Cloud Illuminator**			0 12 6
1392	**Stage Condenser or Side Illuminator,** mounted on jointed arm	7s. 6d.	0 12 6	1 1 6
1393	**Side Speculum Reflector,** mounted as ditto (fig. 1393) .		1 1 0	1 12 0
1394	**Dark Wells or Stops,** three sizes on jointed holder .			0 12 6
1395	**Micrometer for Stage,** divided on glass, $\frac{1}{100}$th and $\frac{1}{1000}$th of an inch			0 10 6
1396	**Noberts' System of Test Lines**			1 10 0
1397	**Polarising Apparatus** fitted to Microscope . . .		2 10 0	3 15 0
1398	**Tourmalines,** mounted to fit eye-tube, price according to quality . . . . from			0 10 6
1399	**Selenite,** mounted for Stage		0 2 0	0 2 6
1400	Ditto ditto in Brass Mount			0 7 6
1401	**Camera Lucida,** Wollaston's, for drawing magnified image, mounted to fit microscope			1 5 0
1402	Ditto ditto with additional lenses and shades (fig. 1402)			1 14 0
1403	**Beale's Neutral Tint Reflector** (fig. 1403) . . .			0 10 6



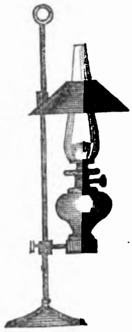
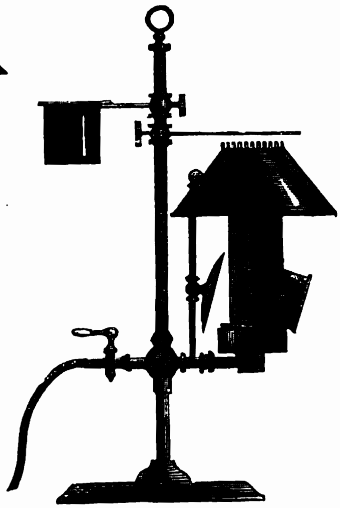


FIG. 1405.



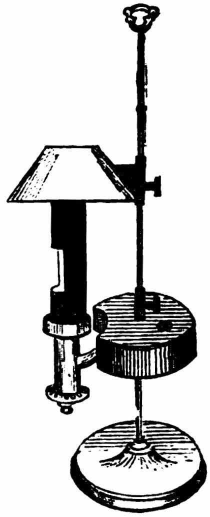


FIG. 1407. FIG. 1406. FIG. 1404.

No.		Each. £ s. d.	Each. £ s. d.
1404	**Improved Argand Oil Lamp,** adapted for Microscopic purposes (fig. 1404)		1 10 0
1405	**Paraffin Microscopic or Reading Lamps,** in various mountings (fig. 1405)	1 10 0	1 15 0
1406	**Microscopic Argand Gas Lamp,** with Improved illuminating lens and chimney, and the stand conveniently arranged for various purposes connected with preparing and mounting microscopic objects. This Lamp can also be used as a Reading Lamp or for Chemical Operations (fig. 1406)		3 3 0
1407	**Paraffin Microscopic Lamps,** with Porcelain Shade, vertical adjustment to both Stand and Shade (fig. 1407)		0 14 0
1408	Ditto ditto in Polished Pine Cabinet		0 18 6
1409	**Bochett's Microscopic Lamp** (Paraffin) Brass Mounted, with Condenser, Reflector, Shade, and universal adjustments; in Mahogany case		3 3 0
1410	**Porcelain Shade,** for Microscopic Lamp		0 1 6
1411	**Lamp Glasses,** for do.		0 0 6
1412	**Forceps,** of several forms, for taking up small objects, dissections, &c. 2s. 6d.	0 3 6	0 5 0
1413	Ditto ditto **Curved for Phials**		0 6 6
1414	**Wood Forceps,** Page's, for mounting objects		0 2 6
1414*	**Stage Mineral Holder**		1 1 0
1415	**Stage Forceps,** with jointed arm, very useful for holding objects while under examination in the microscope (fig. 1415)	0 10 6	0 12 6
1416	**Dissecting Needles,** or Needle holders	0 1 6	0 5 0
1417	**Dissecting Scissors**	0 3 6	0 6 6
1418	Ditto ditto Curved		0 6 6
1419	Ditto ditto Spring		0 10 6

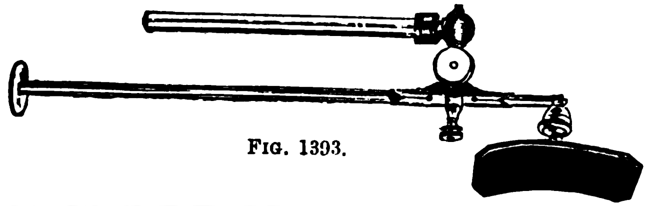


FIG. 1393.

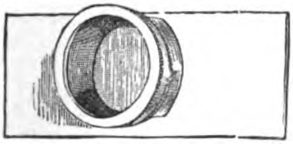


FIG. 1426.

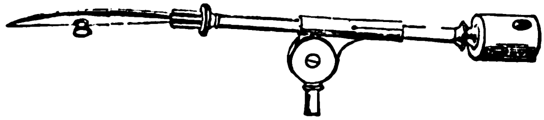


FIG. 1415.

		Each. £ s. d.	Each. £ s. d.
1420	**Dissecting Knives**	0 2 6	0 3 0
1421	**Valentine's Dissecting Knife,** for cutting thin sections of soft animal substances, &c.	0 17 6	1 1 0
1422	**Three-pronged Forceps, of German Silver,** with screw adjustment		0 17 6
1423	Ditto ditto plain mounting		0 15 0
1424	**Microscopic Dissecting Instruments,** in neat case .	1 1 0	2 10 0
1425	**A Selection of all the Necessary Materials** for Mounting Objects, arranged in a mahogany box .	3 3 0	4 4 0
1426	**Glass Cell,** round, for holding fluids, viewing circulation in plants, polyps, &c. (fig. 1426)		0 1 6
1427	**Animalculæ Cage, or Live Box,** for conveniently examining water containing animalculæ, living insects, &c. (fig. 1418) . . . . 5s. 6d.	0 7 6	0 10 6
1428	**Animalculæ Box,** Varley's pattern, with raised centre (fig. 1428)	0 12 6	0 16 0

FIG. 1427.

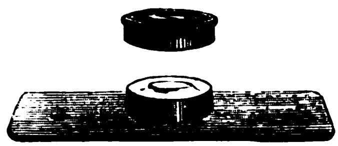


FIG. 1428.

1429	**Compressorium,** for similar purposes, where the object requires greater pressure	0 15 0	1 1 0
1430	Ditto ditto **Best Lever**		1 16 0
1431	**Frog Plate,** for holding Frogs, Fish, &c., to exhibit the circulation of the blood	0 10 6	0 12 6
1432	**Glass Slides,** with ground edges for mounting objects, of the best quality, 3-in. by 1-in. . . . . per doz.		0 1 0
1433	**Glass Rings, Cells, Circles, Squares, &c.,** of various sizes and thicknesses, for mounting injections, &c., from per doz.	0 3 0	0 4 0
1434	**Coloured Paper Mountings for Slides,** „		0 1 0

FIG. 1450.

1452*

		Each.			Each.		
		£	s.	d.	£	s.	d.
1435	**Plate Glass Stage Plates,** with Oval or Round cells per doz.				0	4	0
1436	**Thin Microscopic Glass,** cut in **Squares,** per oz.				0	3	6
1437	Ditto ditto cut in **Circles**	0	6	0	0	10	0

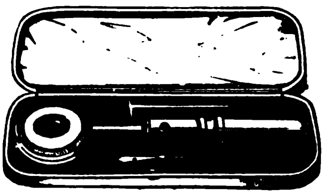


FIG. 1438.

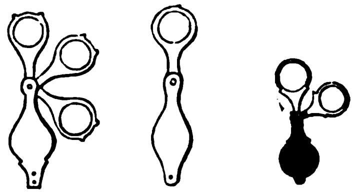


FIG. 1438*.

1438	**Collector's Pocket Microscope,** with two powers and forceps for holding the object, in neat hinged case (fig. 1438)				0	10	6
1438°	**Pocket Microscopes or Magnifiers;** for prices, &c., see page 257.						
1439	**Animalculæ Tubes,** or Collecting Bottles, fitted with corks, for collecting specimens . . . per doz.				0	3	6
1440	Ditto ditto in sets and pocket cases	0	6	0	0	15	0
1441	**Sets of 3 Animalculæ Fishing Tubes,** in case . .				0	2	6
1442	**Ditto 6** ditto ditto				0	5	0
1443	**Writing Diamonds**				0	10	6
1444	**Cutting ditto** . . . . 16s.	1	1	0	1	10	0
1445	**Instrument for cutting Circles of Thin Glass** . .	1	10	0	4	10	0
1446	**Turn Tables** for preparing circular Gold Size cells .				0	10	6
1447	**Section Cutters,** for wood, bone, &c.	1	10	0	2	2	0
1448	**Air Pump** for preparing objects (see also Pneumatic Section).	1	1	0	1	10	0
1449	**Brass Injecting Syringe** for ditto	0	10	6	1	10	0
1450	**Mounting Apparatus or Compressorium,** for preparing Microscopic objects in Canada Balsam, &c. (fig. 1450)				0	12	6
1451	**Canada Balsam** . . . . per bottle				0	1	0
1452	**Turpentine** . . . . „				0	1	0
1452°	**Spirit Lamps** (fig. 1452°), various sizes, see Chemical Section.						

			Each. £ s. d.	Each. £ s. d.
1453	**Gold Size**		per bottle	0 1 0
1454	**Asphalte Varnish**		„	0 1 0
1455	**Damar ditto**		„	
1456	**Glycerine Jelly**		„	0 1 0
1457	**Deane's Gelatine Medium**			0 2 0
1458	**Farrant's ditto**			0 2 0
1459	**Marine Glue**		„	0 1 0
1460	**Æther, Acetic Acid, Liquor Potassæ, Solution of Chromic Acid, Turpentine, Carmine Solution, Logwood Solution, &c., &c.,**		per bottle, from	0 1 0

APPARATUS FOR COLLECTING MICROSCOPIC OBJECTS, &c.

1461	**Collecting or Pond Sticks,** each . . . from		0 2 6
1462	**Spring Clip** for screwing into the end of a walking-stick, with bottle for collecting Animalculæ, &c.		0 4 6
1463	**Metal Ring,** for holding temporary gauze net, to screw into collecting stick		0 3 6
1464	**Spoon,** to screw into collecting stick for gathering diatoms or desmids		0 1 6
1465	**Weed Knife,** for cutting water weeds, to screw into collecting stick		0 3 0
1466	**Strainer,** consisting of a metal cylinder with gauze bottom		0 1 0
1467	**Drag Hooks,** for gathering water weeds		0 2 6
1468	**Collecting Bottles,** clear white glass, with welted necks fitted with corks and turned wood tops—		

Capacity	1	2	3 ounces
Per doz.	3s.	3s. 6d.	4s.

1469	**Set of 6 Collecting Bottles,** in japanned tin pocket case		0 5 0
1470	**Pipettes**	0 0 3	0 0 6

SPECTRUM APPARATUS FOR THE MICROSCOPE.

1471	**Sorby's Micro-Spectroscope**	5 10 0
1472	Ditto ditto with Rack-work motion to the Eye-piece	5 15 0
1473	Ditto Standard Spectrum Scale	1 1 0

MICROSCOPIC OBJECTS.

1474	**A Set of Twenty-four Microscopic Objects,** Transparent and Opaque, dry mounted and named; in a neat box		0 3 6
1475	**An extensive assortment of Balsam mounted Microscopic Objects,** of English and French mounting	0 1 0	0 1 6

These objects consist of insects, part of insects, such as wings and wing-cases, stings, tongues, eyes, dissections of the trachea and bronchial tubes, antennæ, legs, the scales of butterflies and moths, zoophites, ferns, fuci, mosses, madrepores, sections of recent woods, leaves, petals and farina of plants, feathers, hairs, exuviæ of spiders and aquatic insects, algæ or sea weeds, sponges, echinus' spines, shells.

No.	Item	Each. £	s.	d.	Each. £	s.	d.
1476	**Test Objects**, Balsam Mounted—Podura, Hair of Mouse and Bat, Navicula Hippocampus, &c.	0	1	6	0	2	0
1477	**Entomological Preparation—Various Insects**, Acari, Parasites, &c., **mounted in Canada Balsam**, showing the respiratory, digestive, and nervous systems, and their modifications for terrestrial and aquatic habits 1s.	0	1	6	0	2	0
1478	**Vegetable Preparations**, showing spiral vessels, ducts, tissues, raphides, cells and spores in plants; sections of wood, seeds, leaves, petals, fungi, &c.	0	1	6	0	2	0
1479	**Polarising Objects**, consisting of crystalline salts, hoofs, horn, skin, tendon, fish scales, palates of mollusca, and vegetable substances	0	1	6	0	2	0
1480	**Anatomical Injected Preparations**, Transparent and Opaque, muscular fibre tissues, blood discs, pigment cells, &c.	0	2	0	0	2	6
1481	**Sections of Fossil Woods**, Exoginous, cut in three directions				0	10	6
1482	Ditto ditto Endoginous, cut in two directions				0	7	6
1483	**Sections of Limestone, Oolite, Flint**, containing sponges, fish scales, and fossil infusoria				0	4	0
1484	**Sections, Longitudinal and Traverse**, of recent and fossil bones, fossil and recent Teeth, **Sections of Flint** containing Xanthidium	0	2	0	0	3	0
1485	**Diatomaceæ**: Recent and Fossil, numerous varieties of Navicula, Campylodiscus, Cocconema, Epithemia, Desmidiæ, &c., from various parts of the World	0	1	6	0	2	0
1486	**Cabinet**, of polished Mahogany, for containing **Microscopic Objects**, fitted with drawers and divisions				3	3	0
1487	**Cabinet** ditto Spanish Mahogany, to hold 1,000 objects				6	6	0
1488	Ditto ditto with Plate Glass Doors				8	8	0
1489	**Polished Pine Wood Boxes**, with trays to hold three dozen objects				0	4	6
1490	Ditto ditto for six dozen ditto				0	10	6
1491	Ditto ditto for six dozen ditto with lock and key				0	12	6
1491*	Mahogany Racks for holding objects, per foot, 1s.						
1492	**Cardboard Boxes**, with wood racks, to hold 1 dozen 1s., 2 dozen, 2s.						
1493	**Microscopic Tables**, of polished Rosewood, Walnut, or Mahogany, the top covered with leather or cloth £6 6s.	8	8	0	10	10	0

A SPECIAL MEDAL

AWARDED TO

NEGRETTI AND ZAMBRA

FOR

MICROSCOPES.

Philadelphia International Exhibition, 1876.

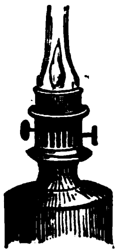


FIG. 1497*.

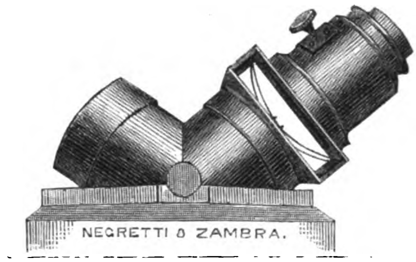


FIG. 1497.

POLARISCOPES AND POLARISING APPARATUS.

No.	Description	Each. £ s. d.	Each. £ s. d.
1494	**Tourmaline Polariscope,** elementary form—two plates of tourmaline arranged in spring wire forceps for holding any crystal to be examined between them, and also to show that light passes when the two Sections are parallel to each other, and is stopped when they are at right angles to each other, very useful for testing Pebble Lenses in Spectacles . .		1 5 0
1494*	**Reflecting Polariscope,** Malus's. The Polarising and Analysing bundles are formed of very thin plates of Glass mounted in brass frames and supported on a metal stand so as to be adjustable at any desired angle. Between these Bundles or Mirrors is arranged a stage for holding the crystals, &c., to be examined, this stage having horizontal movement, with a graduated circle for noting the angle of rotation, &c.		3 3 0
1495	**Biot's Improved Black Mirror Polariscope.** In this instrument **Black Glass** Mirrors are used instead of the bundles of Glass, and these Mirrors are fitted with divided arcs for adjusting them to any angle. The rotating stage has also a divided circle and a spring clip object holder to support the crystals, &c., under examination		5 5 0
1496	**Biot's Polariscope,** complete with tourmaline, plate of selenite of uniform thickness, double image prism, brass frame for showing polarising structure produced by unequal pressure in a piece of annealed glass, with diaphragm of greyed glass, &c.; in Cabinet .		6 10 0
1497	**Woodward's Table Polariscope** (fig. 1497), for conveniently illustrating the interesting phenomena of Polarised Light, fitted either with a bundle of thin glass or a black mirror. Large and small stage with spring object holder, Rack-work adjustments to eye-tube, Powers, &c., &c., complete in a Cabinet forming a stand for the instrument		10 10 0

Woodward's Polariscope can be supplied for use with the Oxy-Hydrogen Microscope (fig. 1588, page 320), at a slight additional cost.

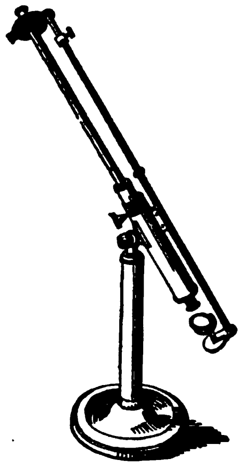


FIG. 1499.

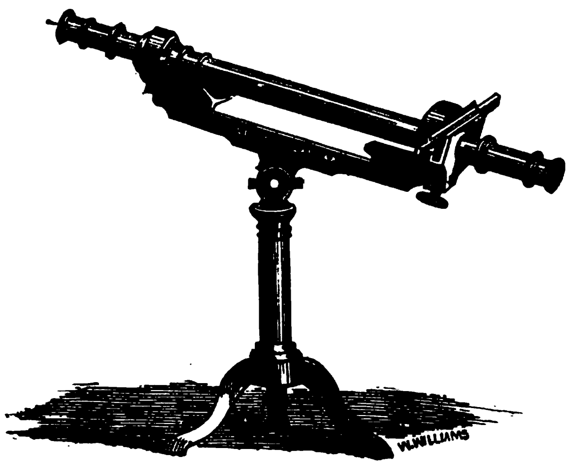
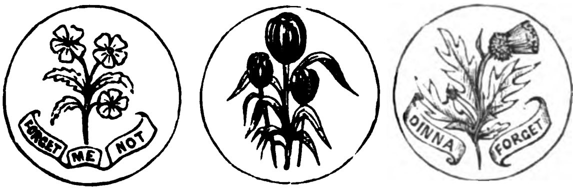


FIG. 1500.

1498	**Tourmaline Polariscope,** A frame, having a revolving disc carrying a series of crystals, which may be successively brought between the tourmalines; each of the latter can be made to revolve in its own plane, and thus place their axes parallel or perpendicular to each other at pleasure, and vary the phenomena of each crystal		£4 10 0
1499	**Polariscope,** for the examination of fluids, with prisms, tourmalines, reflecting mirror, divided circle, with micrometer, &c., mounted on a firm brass stand, with convenient adjustments (fig. 1499)		12 12 0
1500	**Duboscq Soleil's Polariscope or Saccharimeter,** for estimating the value of fluids, &c., with the most recent improvements (fig. 1500)		15 15 0
1501	**Double Image Prism,** Selenite disc of equal thickness, and three-hole slider for ditto, for showing the production of white light by the union of the complimentary colours		£1 1 0
1502	**Unannealed Glass,** various shapes, for showing the permanent polarising structure of glass that has been uniformly heated and suddenly cooled . . .		0 5 6
1503	**Brass Frame,** for showing the transient polarising structure communicated by Pressure to a piece of annealed glass		0 10 0
1504	**Apparatus,** for showing the same effect by the unequal application of Heat		0 8 6
1505	**Polarising Eye-piece** of thin glass, in brass mount .		0 5 0
1506	**Nicol's Single Image Calc-Spar Prism** . 12s, 15s.	1 6 0	1 10 6
1507	**Nicol's Double Image Prism of Calc-Spar** . . .		0 18 0
1508	**Tourmalines** of various sizes and colours . . 8s.	0 12 6	1 10 0
1509	**Artificial Tourmalines**	0 15 0	1 1 0
1510	**Thin Selenite Plates** of equal and unequal thickness, developing uniform or various colours . . .	0 3 0	0 4 0



1 2 3

FIG. 1511.

1511	**Selenite Designs** are formed of pieces of selenite different in thickness, arranged in a variety of forms, such as cubes or stars, for showing the beautiful colours produced by the varying thickness of the film of selenite. each	10s. 6d.	£1 10 0
1512	**Design in Selenite**, with motto on ribbon, "Forget-me-not"—1 (fig. 1511)		0 18 6
1513	**Thistle, in Selenite**, with motto on coloured ribbon, "Dinna Forget"—3		0 18 6
1514	**Tulip in Selenite—2**		0 18 6
1515	**Selenite Design** of a Gothic Church Window . .		3 3 0
1516	**Circular Plate of Selenite**, ground concave, to develop the colours in rings		0 16 0
1517	**Rhombs of Iceland or Double Refracting Spar**, to show the multiplication of images afforded by peculiar structure of the crystal . . . . . 6s. 6d.	0 10 6	1 10 0
1518	**Plates** of Quartz, Arragonite, Amethyst, Topaz, Calc-Spar, Borax, Nitre, Beryl, Rochelle Salts, Sugar, Bi-chromate of Potass, Sulphate of Iron, cut at right angles to their axis, for exhibiting coloured rings, compound figures, bars and cross-bars, screws, and crosses, &c. 10s. 6d.,	1 1 0	2 0 0
1519	**Sliders**, with fish fins and scales, laminæ of human cuticle, sections of teeth, bones, hoofs, horns, and tendon, various chemical salts and vegetable productions, &c., preserved in Canada Balsam, to exhibit their polarising structure; adapted for the Table Polariscope	0 1 6	0 2 6

GLASS, QUARTZ, AND OTHER PRISMS, AND EVERY DESCRIPTION OF APPARATUS OR OBJECTS PREPARED FOR EXPERIMENT WITH POLARISED LIGHT.

Polarising Apparatus fitted to Table or Lime Light Microscopes.

Pereira's Lectures on Polarised Light; Delivered before the Pharmaceutical Society of Great Britain. Second Edition. Price 4s.

Professor Roscoe's *Lectures on Spectrum Analysis* (Third Edition), largely Illustrated. Six Lectures on Spectrum Analysis and its Applications, delivered before the Society of Apothecaries. Price £1 1s.

SPECTRUM APPARATUS.

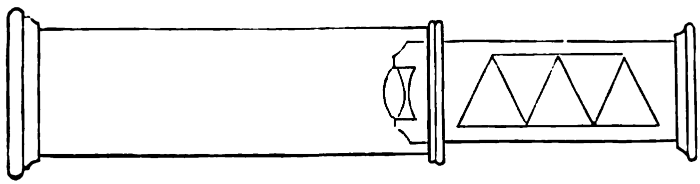


FIG. 1520.

No.		Each. £ s. d.	Each. £ s. d.
1520	**Pocket Spectroscope,** with five Prisms, and adjustable slit, will show many of Fraünhofer's lines (fig. 1520)		1 15 0
1521	**Spectrum Apparatus** (or Spectroscope), simple form for chemical analysis, with Micrometer adjustments	7 7 0	12 12 0

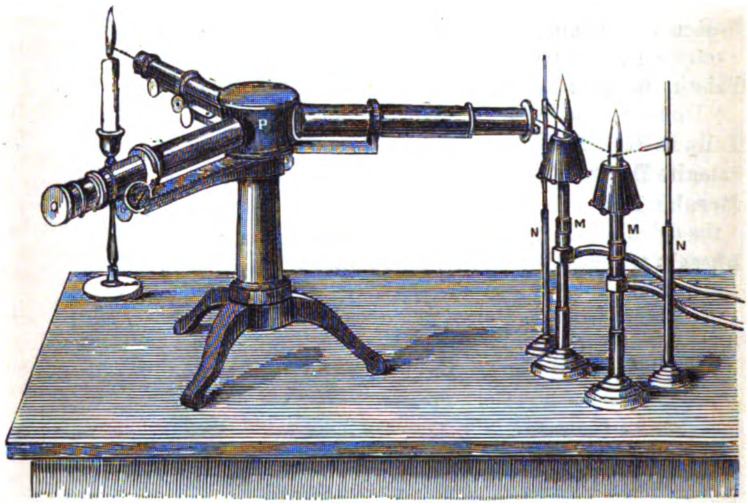


FIG. 1522.

No.			Each. £ s. d.	Each. £ s. d.
1522	**Spectroscope,** Duboscq's arrangement, one **Prism,** horizontal telescope, and transparent micrometer, gas burner, and forceps; on adjusting stand (as fig. 1522)			15 15 0
1523	Ditto ditto with Four Prisms			35 0 0
1524	Ditto ditto with Six Prisms			50 0 0
1525	**Prisms** of Glass, of various density . .	£1 1 0	2 2 0	3 3 0
1526	**Bisulphide of Carbon Prisms**		0 15 0	1 1 0
1527	**Spring Stage,** for studying the absorption spectra of coloured glasses			0 11 0
1528	**Gladstone's Wedge,** for exhibiting the absorption spectra			1 12 0
1529	**9-inch Glass Tube,** with stop-cock, for examining the dark lines seen in gases and vapours			0 12 6
1530	**A Divided Tube,** with two compartments and two flasks, connectors, stop-cock, &c., for exhibiting the increase of dark lines with increased temperature and length of vapour			2 2 0
1531	**Bunsen's Steatite Burner,** with copper cone, mounted on a stand (M fig. 1522)			0 12 6
1532	**Spectroscope Forceps** (or Pincettes), on an adjusting support (N fig. 1522)			0 11 0

See Section Electric Light for Lantern Spectrum Apparatus.

CROOKES' RADIOMETER.

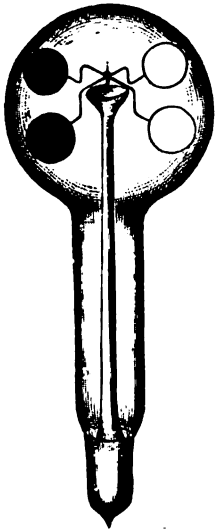


FIG. 1532†.

This Instrument demonstrates the supposed conversion of Light into Mechanical Motion, invented by Mr. William Crookes, F.R.S., and first exhibited by him at the Soirée of the Royal Society, *April 7th*, 1875, and described by him in the *Quarterly Journal of Science*, for *July*, 1875, as follows:—

"The Instrument which I have called a Radiometer, shown in fig. 1532†, consists of four arms, of some light material, suspended on a hard steel point resting in a cup, so that the arms are able to revolve horizontally upon the centre pivot, in the same manner as the arms of Dr. Robinson's Anemometer revolve. To the extremity of each arm is fastened a thin disc of roasted mica or pith, white on one side and lamp-blacked on the other, the black surfaces of all the discs facing the same way. The whole is enclosed in a thin glass globe, which is then exhausted to the highest attainable point and hermetically sealed.

"The arms of this Instrument rotate with more or less velocity under the action of radiation, the rapidity of revolution being directly proportional to the intensity of the incident rays. Placed in the Sun or exposed to the light of burning Magnesium, the rapidity is so great that the separate discs are lost in a circle of light. Exposed to a Candle 20 inches off another instrument gave one revolution in 182 seconds; with the same Candle placed at a distance of 10 inches off the result is one revolution in 45 seconds; and at 5 inches off one revolution was given in 11 seconds. Thus it is seen that the mechanical action of radiation is inversely proportional to the square of the distance. At the same distance 2 Candles give exactly double, and 3 Candles give three times, the velocity given by 1 Candle, and so on up to 24 Candles. A small Radiometer was found to revolve at the velocities shown in the following table, when exposed to the radiation of a standard Candle 5 inches off.

Time Required for One Revolution.

Source of Radiation.	Time in Seconds.
1 candle, 5 inches off, behind green glass	40
„ 5 „ „ blue „	38
„ 5 „ „ purple „	28
„ 5 „ „ orange „	26
„ 5 „ „ yellow „	21
„ 5 „ „ light red „	20

"The position of the light in the horizontal plane of the Instrument is of no consequence, provided the distance is not altered; thus two candles, 1 foot off, give the same number of revolutions per second, whether they are side by side or opposite to each other. From this it follows that if the radiometer is brought into a uniformly lighted space it will continue to revolve.

"In diffused daylight, the velocity was one revolution in from 1·7 seconds to 2·3 seconds, according to the intensity of the incident rays. In full Sunshine, at 10 A.M., it revolved once in 0·3 second, and at 2 P.M. once in 0·25 second.

"When heat is cut off by allowing the radiation to pass through a thick plate of Alum, the velocity of rotation is somewhat slower."

1532† **Crookes' Radiometer**, with Black and White Discs (as fig. 1532†), on Mahogany Stand £1 5 0

For further details of Preliminary Experiments and Researches, &c., &c., see Pamphlet, *Crookes' Radiometer*. Price 1s.

NEGRETTI AND ZAMBRA'S
IMPROVED
MAGIC AND PHANTASMAGORIA LANTERNS,
APPARATUS FOR EXHIBITING DISSOLVING VIEWS,
TRANSPARENT PHOTOGRAPHIC VIEWS AND STATUES,
&c., &c., &c.

A detailed description of these Lanterns, Slides, &c., &c., will be found in Negretti and Zambra's Illustrated Lantern Manual (price 1*s.), on the pages indicated at the top of each section of this List.*

From a mere amusing toy, the Magic Lantern has become a most efficient assistant to the parent and teacher, in communicating information to the young on a vast variety of topics, and a most valuable auxiliary to the lecturer in his popular illustrations of science. Thousands gaze with delight upon the wonders and beauties of nature, now portrayed in something like reality and truth.

The invention and early history of the Magic Lantern appears to be involved n some doubt and uncertainty. It is highly probable that the mode of producing images by an apparatus similar to that of the Magic Lantern was early discovered, and may have been used by men who claimed occult powers in producing those appearances which have by the uninformed of all ages been deemed supernatural. Dr. Thomas Young asserts that Friar Roger Bacon, who was educated at Oxford, invented and used a Magic Lantern in 1252. This, most probably, was some arrangement of concave mirrors, the use of which was well known to the ancients. It is, however, certain that in a Latin book, *Ars Magna Lucis et Umbræ*, published in the middle of the seventeenth century by Athanasius Kircher, a description is given of a Magic Lantern used by him at the Jesuits' College, in Rome, and also that a mathematician, Walgenstenius, appears to have had some share in perfecting and using the instrument. The apparatus was very large and imperfect, and the paintings of the roughest style of art; but being concealed from the spectators it excited much astonishment, and in many considerable alarm. One of our old dictionaries defines the Magic Lantern as "a small optical instrument which shows, by a gloomy light on a wall, monsters so hideous, that those who are ignorant of the secret believe it to be performed by magic art." Another book describes it thus—"Majick Lanthorn, a little optick machine, by means of which are represented in an obscure place many hideous shapes, which are taken to be an effect of majick by those ignorant of the device." This description conveys a very imperfect idea of the modern Magic Lantern now used to exhibit the scenery of nature, or the wonders of art, in all their minuteness of detail, and beauty of colour.

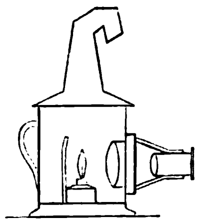


FIG. 1533.

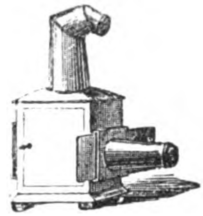


FIG. 1534.

MAGIC LANTERNS FOR EXHIBITING COMIC AND AMUSING SUBJECTS.

1533 **Magic Lantern** (fig. 1533) **and one dozen Amusing Comic Sliders,** in a box with about 50 figures:—

No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
7s. 6d.	10s. 6d.	23s.	30s.	42s.

		Each. £ s. d.	Each. £ s. d.
1534	**Magic Lantern, No. 6,** with Solar Argand lamp, in a box, with one dozen amusing Comic sliders (fig. 1534)		3 0 0
1535	**Magic Lantern, No. 7,** size as No. 6, including Microscope to attach to front, with six microscopic objects, water trough, &c., complete; in case . .		5 5 0
1536	**Views** of various interesting localities, suited for Nos. 5 and 6	0 3 0	0 2 6
1537	**Comic Moving or Slip Slides** for Nos. 4, 5, and 6, 1s. 6d.	0 2 0	0 2 6
1538	**Lever Slides** for ditto		0 5 6
1539	**Chromatrope** for No. 5 and 6		0 8 0

1540 **Astronomical Slides** for above Lanterns:—

No. 3.	No. 4.	Nos. 5 & 6.
30s.	40s.	50s.

1541	**Natural History Slides** for No. 3, No. 4, No. 5 & 6, 30s.	2 2 0	3 3 0
1541*	**Estimate A.**—No. 6 Magic Lantern, with a selection of Sliders sufficient for an entertainment, including a box of 12 Numerous slides, about 50 figures: 6 moving Comic slides, a Fairy Tale 6 slides, 1 Chromatrope, and one of Negretti and Zambra's Photographic Statues		5 5 0
1541†	**Estimate B.**—A similar set to the above, but with 6 additional Coloured Views, 1 Lever Slide, and 2 Negretti and Zambra's Photographic Statues . .		6 16 0

PHANTASMAGORIA LANTERNS.—(Pp. 5 and 6.)

1542	**Phantasmagoria Lantern,** with two condensing lenses 3-inch diameter, mounted in brass cells, Sliding tube for adjusting the focus, improved **Fountain Argand Lamp** and Reflector, &c., complete; will give a magnified image of a painting 2½ inches diameter, on a disc of 8 feet diameter (fig. 1542) .	2 12 6
1542*	Ditto ditto with Rackwork adjustment	3 0 0

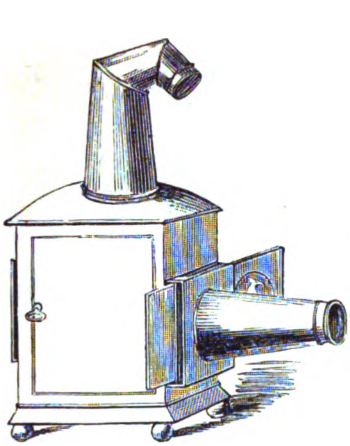


FIG. 1542.

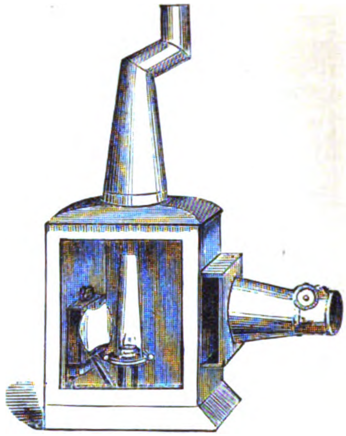


FIG. 1545.

		Each. £ s. d.	Each. £ s. d.
1543	**Very Superior large-sized Phantasmagoria Lantern,** with 3½-inch condensing lenses, sliding tube for adjusting the focus, improved **Fountain Argand Lamp,** with Reflector complete, of the very best construction; to show a 3-inch painting on a disc of 10 feet diameter		3 3 0
1544	Ditto ditto with **Rackwork** adjustment		3 12 6
1545	Ditto ditto, 4-inch, with ditto ditto (fig. 1545)		5 10 0

These Lanterns are so much improved, and used with such facility, that they may be recommended with the greatest confidence, giving a perfectly defined figure, with a well illuminated field of view, from 6 to 12 feet in diameter. Combined with **Negretti and Zambra's Coloured Photographic Slides,** they present a novel and delightful mode of instruction and amusement. To Schools, Mechanics' Institutes, &c., they offer peculiar advantages, and are extensively used by the conductors of these institutions for illustrating almost every branch of scientific information.

1546 **Estimate for Sets of Lantern Sliders.**—A box of 12 best Comic sliders, 12 moveable Comic slip slides, 2 sets of Fairy stories, 2 best Chromatropes, 2 lever sliders, 6 Coloured views, and 3 Negretti and Zambra's Photographic Statues.

With Phantasmagoria Lantern as—

No.		11 11 0
No. ditto ditto		12 12 0
No. ditto ditto		14 14 0

1547 **A Microscope** adapted to the above Lanterns, at £2 2 0 additional, will show small objects brilliantly enlarged on a disc 4 feet in diameter.

1547* **Balsam-Mounted Microscopic Objects,** suited for above, 2s. to 2s. 6d. each.

An Improved form of Paraffin Lamp can be supplied with the Lanterns Nos. 1543 to 1545, in place of Oil Lamps, giving a larger disc with the same amount light as the Sciopticon, described on another page.

SLIDES FOR MAGIC LANTERNS.

(Pp. 6 to 10.)

FIG. 1548.

No.	Description	Each. £	s.	d.	Each. £	s.	d.
1548	**Largest Size Best Painted Comic Lantern Slides,** one dozen in box (fig. 1548)				3	3	0
1549	Fourteen-inch Comic Slides, one dozen in box . . .	1	10	0	2	2	0
1550	Twelve-inch ditto ditto ditto . . .				1	4	0
1551	**Fairy and Nursery Tales or Stories,** painted on Three-Inch circles:—Cinderella, Robinson Crusoe, Blue Beard, John Gilpin, Robin Hood, Jack the Giant Killer, Jack and the Beanstalk, Tale of a Tub, Whittington and His Cat, St. George and the Dragon, Sinbad, Aladdin, &c., &c., Per Set of six and seven slides	1	1	0	1	10	0

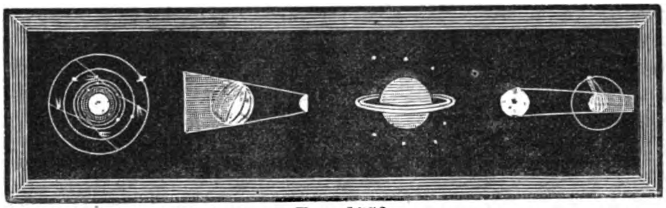


FIG. 1553.

No.	Description	Each. £	s.	d.	Each. £	s.	d.
1552	**Astronomical Sliders,** for illustrating the various Phenomena of Astronomy, with Descriptive Book, for the small size Phantasmagoria Lantern, in box .				2	2	0
1553	Ditto ditto for the Second Size (fig. 1553) .				3	3	0
1554	**Astronomical Sliders or Diagrams,** Best Painted, Large Size on single Blocks; in box with book . .	4	4	0	5	5	0
1555	**A Series of Ten finely painted Astronomical Diagrams, with Rack and Pinion movements,** by which the images produced are made to move or revolve; in box for large sized Lanterns . . . . . £6 6s.	8	8	0	10	10	0
1556	**Sets of Natural History Slides,** consisting of correct drawings of Mammalia, Birds, Fishes, and Reptiles 42s.	3	3	0	4	4	0
1557	**Geological Slides,** showing the Earth's strata, with figures of fossil animals and plants, &c.	3	3	0	4	4	0
1558	**Series of Slides,** illustrating Scripture History, Botany, or Zoology, Places and Mountains mentioned in the Bible, painted to order						
1559	**Portraits of Celebrated Individuals** . from each				0	10	6
1560	**Comic Moveable and Shifting Glass Slides** (or Slip Slides)—a diversity of subjects, the magnified images appearing on the screen to have life and motion (figs. 1560 and 1560*) . . . . . 2s., 2s. 6d.	0	3	0	0	5	0

FIG. 1560.

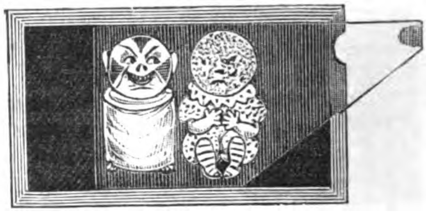


FIG. 1560*.

		Each. £ s. d.	Each. £ s. d.
1561	**Landscapes and Marine Views and Railways,** or Panoramas with moveable Figures, Shipping, Railway Trains, &c. (fig. 1561)	0 10 6	0 16 0

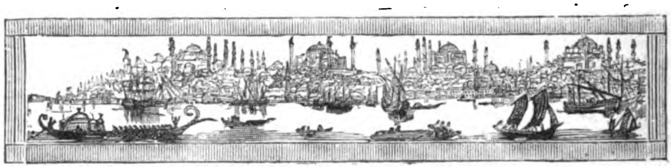


FIG. 1561.

		Each. £ s. d.	Each. £ s. d.
1562	**Lever Slide,** representing the movements of animals, birds, &c., such as a Stag or Swan drinking (fig. 1562)	0 6 6	0 10 6
1563	**Mechanical Slide,** representing a **Dog Begging,** with a pipe taken from the mouth of his master and placed in the dog's mouth		0 12 6
1564	Ditto ditto, with **Moving Smoke** effect—2 slides		1 5 0
1565	**Mechanical Slide,** the **Rat Eater,** representing a sleeping man, with rats running over the bed, and down his throat		0 12 6

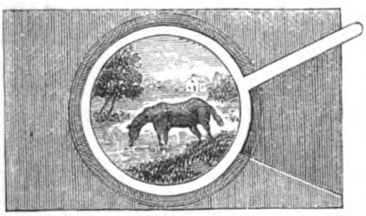


FIG. 1562.

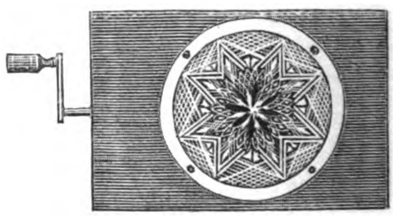


FIG. 1566.

		Each. £ s. d.	Each. £ s. d.
1566	**C. romatropes** (best painting), a variety of beautiful and brilliant designs (fig. 1566)	0 11 6	0 12 6
1567	Ditto ditto Small size		0 8 6
1568	**Chromatrope** with **Motto** or **Design** in the Centre	0 14 0	0 16 0
1569	**Rackwork Slides,** to represent Wind and Water Mills in motion on the screen—best paintings		0 14 0
1570	**A Rackwork Slide,** to show the Aurora Borealis, with a view in the Polar Regions		1 4 0
1571	**Rackwork Fountain Effect**	0 14 0	1 10 0

		Each. £ s. d.	Each. £ s. d.
1572	**Mechanical Slide,** to represent the effects of a Snow Storm		0 12 6
1573	**Mechanical Slide,** representing Moving Water, simple, from		0 12 6
1574	**Mechanical Slide,** Best Painted to represent Shipping, with moving Waves and Birds, &c., a most pleasing effect		1 10 0
1575	**Mechanical Slide,** for Curtain Effect		0 16 0
1576	Ditto ditto an Aquarium, with moving Fish .		0 14 0
1577	Ditto ditto a Scene at a Fair, with moving Swing (lever motion)		0 10 6

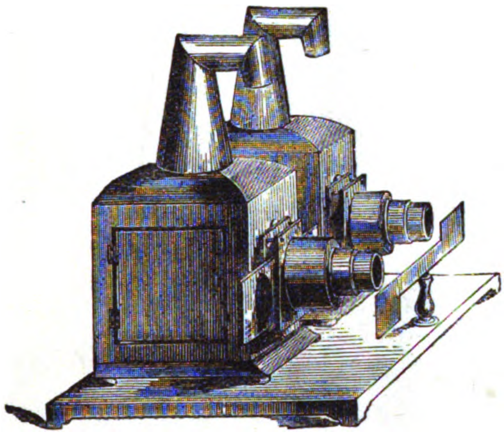


FIG. 1578.

APPARATUS FOR EXHIBITING THE DISSOLVING VIEWS, WITH IMPROVED FOUNTAIN ARGAND OIL LAMPS.

The enchanting optical effect termed Dissolving Views is produced by means of two Phantasmagoria Lanterns, so arranged on a stand that the centre of the discs or pictures projected by each are coincident, and the dissolving or blending of the pictures is effected by a contrivance in front of the two Lanterns, which gradually shuts off the image thrown from one Lantern, whilst the other becomes gradually clearer, until a perfect picture is seen on the disc; a fresh picture being put into the darkened lantern, the action is reversed.

		£ s. d.	£ s. d.
1578	**Dissolving View Apparatus,** adapted for parlour use, consisting of two of Negretti and Zambra's Superior Lanterns with **Rackwork** adjustment to the front Lenses, mounted, with Dissolving Apparatus. In this arrangement the views are exhibited with clearness and brilliancy on the screen, from 6-feet to 10-feet diameter, by improved Fountain Argand Oil lamps and Reflectors. It is simple in use, and well adapted for private exhibition (fig. 1578)	8 8 0	10 10 0

Messrs. Negretti and Zambra can confidently recommend the Apparatus at £10 10s. as being of the most improved construction, and particularly adapted for the purposes of instruction or amusement, where the expense or trouble of the Oxy-Calcium or Oxy-Hydrogen Light cannot be undertaken. If desired, *paraffin* lamps can be supplied to these Lanterns, as mentioned on the previous page in place of Oil Lamps.

Prize Medal, 1851. Honourable Mention, Paris, 1855.

TWO
PRIZE MEDALS
1862.

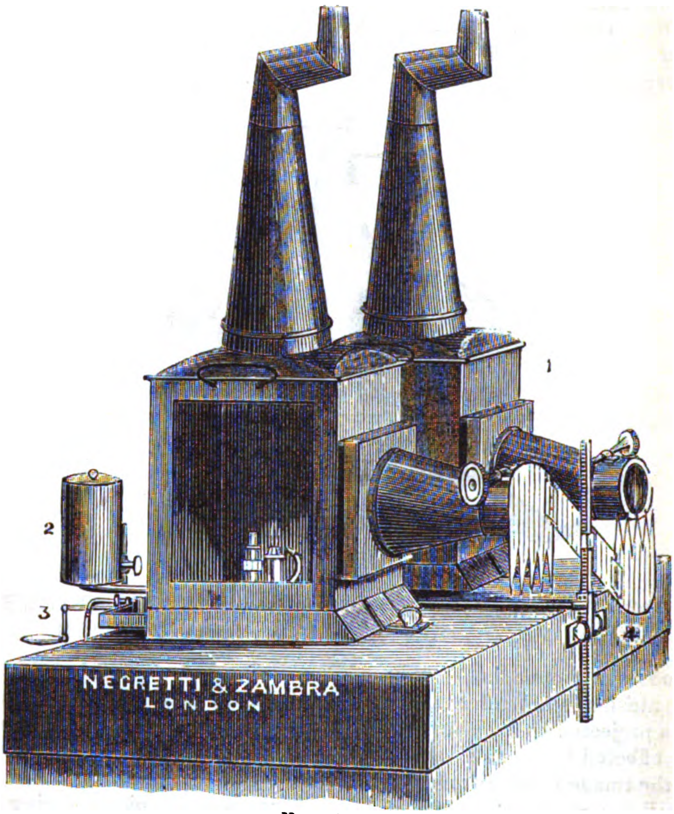


FIG. 1582.

THE OXY-CALCIUM LIGHT.

Messrs. Negretti and Zambra would call especial attention to the **Oxy-Calcium Light,** which, at a trifling advance on the expense of the best Argand Oil lamps, gives a light very nearly equal to the Oxy-hydrogen Light. It is perfectly safe, easily managed, and occupies small space; very cleanly in use, all grease and smoke being avoided. With the Oxy-Calcium Light a brilliantly illuminated disc may be obtained 14 to 16 feet diameter.

		Each. £	s.	d.
1579	**A best Phantasmagoria Lantern,** with $3\frac{1}{2}$-in. Condensing Lenses, fitted with the **Oxy-Calcium Light.** Apparatus for making the Oxygen gas, Gas Bag, and Pressure Board, Conducting tube, &c., complete; in box	8	8	0
1580	A ditto ditto with Rackwork Adjustment to front Lenses .	9	9	0
	A ditto ditto with 4-inch Condensing Lenses, &c., complete; in box	11	11	0

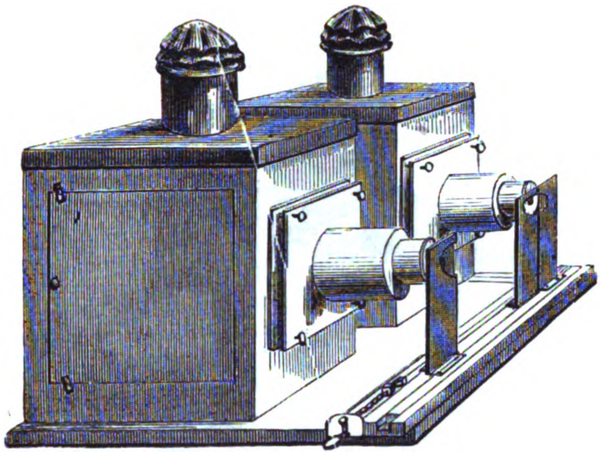


FIG. 1584.

1581 **Dissolving View Apparatus,** fitted with **Oxy-Calcium Light,** condensing lenses, 3½-inch diameter, complete with apparatus . . . £14 14s.
1582 Ditto ditto with Rackwork Adjustments (fig. 1582) . . 15 15s.
1583 **Dissolving View Apparatus,** fitted with **Oxy-Calcium Light,** condensing lenses, 4 diameter, Rackwork Adjustments, complete with apparatus, £17 17s.

Argand Oil Lamps are supplied with the above marked thus * for use when the Oxy-Calcium Light is not convenient.

The Lanterns Nos. 1597 and 1580, and Dissolving View sets 1578 to 1583, can be fitted with the Oxy-Calcium *Gas* jets (as shown fig. 1597), in place of the Spirit Burners at the same cost.

The light obtained by this arrangement is almost equal to the Oxy-Hydrogen, and is **Quite Safe.** Wherever Coal Gas is laid on to the house or building wo should advise the use of this jet, being far superior to the Oxy-Calcium; but where pictures of more than 20 feet in diameter are desired, the Oxy-Hydrogen Light must be used.

THE OXY-HYDROGEN LIGHT.

1584 **Dissolving View Apparatus,** illuminated by the **Oxy-Hydrogen Lime Light,** giving a brilliant and distinct picture on the disc 30 feet diameter. Consists of two Mahogany Lanterns with best condensing lenses, 4½-inch diameter, Brass fronts and slide holders, mounted on a stand; dissolving apparatus, improved Oxy-Hydrogen Jets and Limeholders: flexible connecting Tubes, with stopcocks; gas-bags with Pressure Boards; Hydrogen Generator and Purifier; Oxygen Retort and Conducting Tubes, &c., complete with **Clock Work Motions** (best manufacture), adapted to the limeholders for keeping the lime cylinders slowly revolving and exposing a fresh surface to the action of the gases. **The best form of apparatus for exhibiting the Photographic Views** (fig. 1584) . . . £47 0 0

This Apparatus is supplied either as shown in fig. 1584 or fig. 1585 as may be desired.

Dissolving View Apparatus, figs. 1578 and 1582, if mounted with **Mahogany Lanterns,** as fig. 1584, will be 42s. the pair extra.

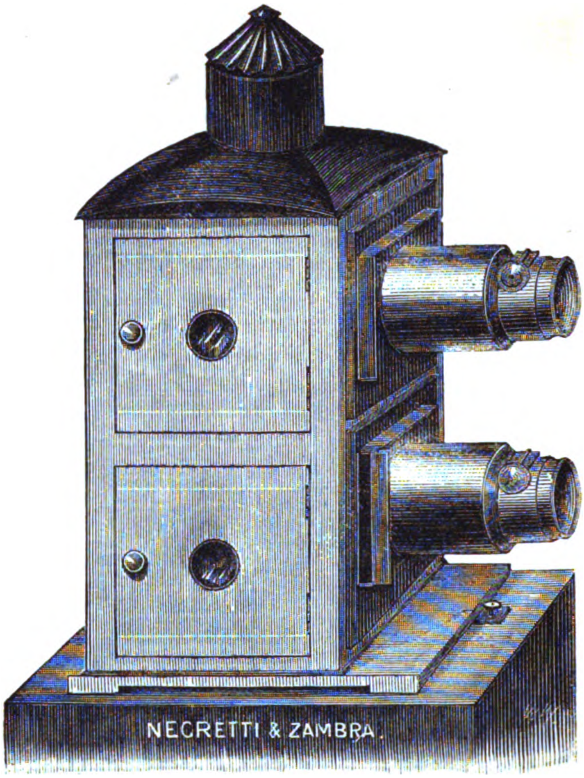


FIG. 1585.

NEGRETTI AND ZAMBRA'S IMPROVED BI-UNIAL OXY-HYDROGEN LIME LIGHT DISSOLVING VIEW APPARATUS.

1585 **Mahogany Lantern Lined with Tin** (as fig. 1585), having 3½-inch Condensing Lenses, Brass Mounts to Front Lenses with Rackwork Adjustments, Japanned Tin Sliding Front to vary distance between Lantern and Screen. Complete with Apparatus for making and purifying the Gas. Full size Gas Bag and Pressure Boards. Flexible conducting Tubes and Connectors, &c., &c. To give a brilliant Disc of 12 to 16 feet in diameter from Paintings 3¼ inch diameter £27 0 0

1586 Ditto ditto as above, but with 4 inch Condensing Lenses for producing a Disc of 16 to 20 feet diameter £31 10 0

1587 Handsome **Brass Fronts** to either of the above Sets with Extra Lenses and mountings for projecting a smaller picture at great distance. each extra £3 0 0

The arrangement of Lanterns (as fig. 1585) can only be effectively used with the Oxy-Hydrogen Lime Light, the vapour or smoke given off in the lower Lantern injuriously affecting the Light in the upper one.

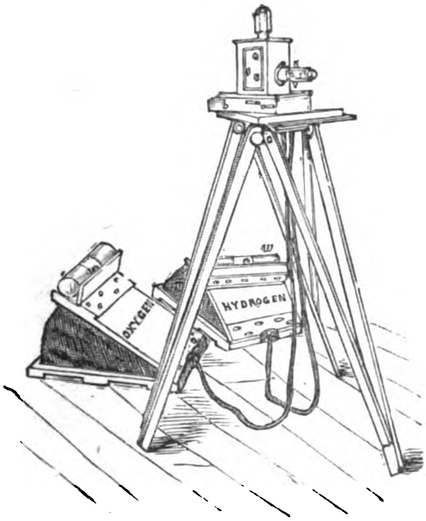


FIG. 1588.

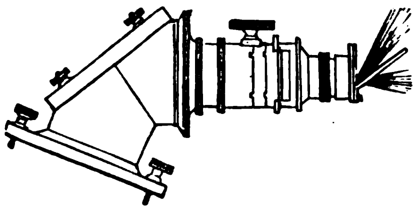


FIG 1589.

OXY-HYDROGEN MICROSCOPE AND POLARISCOPE, &c.

1588 **Portable Hydro-Oxygen Gas Microscope.** The Microscope is furnished with one Low Power for showing full-sized objects, such as entire butterflies; a Second Magnifying power for living aquatic insects, such as the skeleton larva, globe insect; and a Third High Power for smaller objects, such as the dust of moths' wings, &c. The whole Apparatus complete with every requisite for preparing, purifying, and retaining the gases, and with best Lime Clock £37 0 0

This Microscope is capable of showing objects magnified on a disc from two thousand to two million times.

		Each. £ s. d.	Each. £ s. d.
1589	**Polariscope,** to attach to condensing lenses of the Oxy-Hydrogen Microscope (fig. 1589) . . .		15 15 0
1590	**Kaleidoscope,** for the Lantern		2 2 0
1591	**Glass Water Trough,** for exhibiting living Animalculæ, the Voltaic Decomposition of water, the formation of Magnetic Curves by Iron filings on the poles of a horse-shoe Magnet, &c. (fig. 1591) . . . . 5s.	0 7 6	0 10 6
1592	**Extensive Assortment of Large Objects,** prepared in Canada Balsam for the Gas Microscope each 2s. 6d.	0 5 0	0 10 0

OXY-HYDROGEN OPAQUE MICROSCOPE.

1593	**The Aphengescope,** a modified arrangement of the above Apparatus, adapted for use with a pair of Dissolving View Lanterns	2 2 0
1594	**Aphengescope,** for a Single Lantern (fig. 1594) .	0 18 6

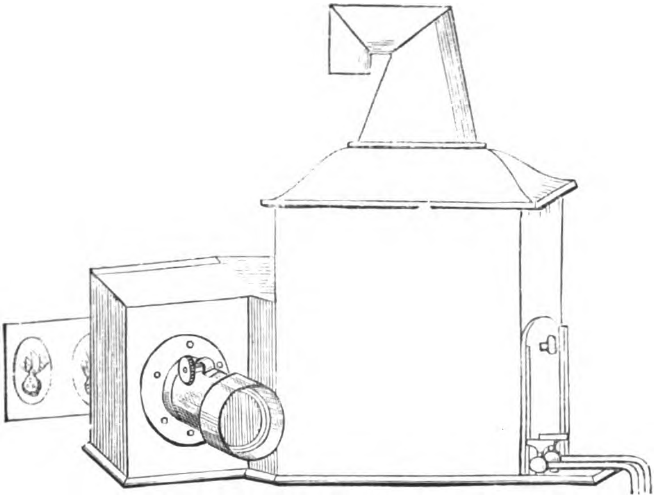


FIG. 1594.

FIG. 1595.

1595 **Improved Apparatus** for exhibiting **OPAQUE OBJECTS, CARTE-DE-VISITE PORTRAITS, &c.,** magnified by the Oxy-Hydrogen Light, upon a Screen in their natural colours (fig. 1595), Complete £26 5 0

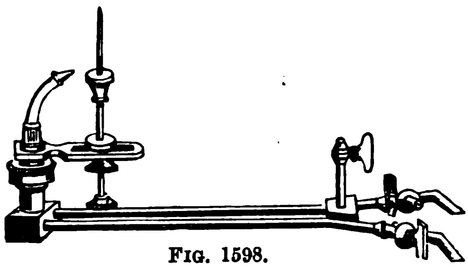


FIG. 1598.

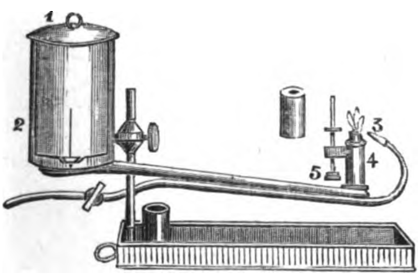


FIG. 1596.

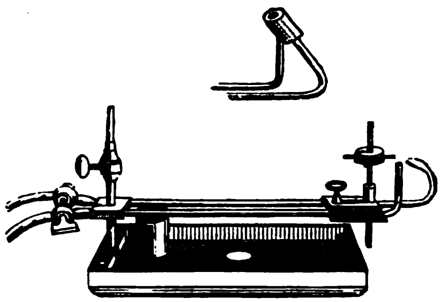


FIG. 1597.

		£	s.	d.
1596	**Oxy-Calcium Spirit Lamp** (fig. 1596)	0	15	6
1597	**Oxy-Calcium Gas Jet** or Blow-through Jets to burn Carb-Hydrogen Gas (fig. 1597)	1	5	6
1598	**Oxy-Hydrogen Burner** (fig. 1598)	2	0	0

1599 **Oxy-Calcium Spirit Lamps, Oxy-Calcium Safety Gas Lamps and Oxy-Hydrogen Gas Burners,** fitted with the Registered Cog Wheel Lime Adjuster, a cheap and useful substitute for the Lime Clock, at about 7s. 6d. each, Lamp extra on the above prices.

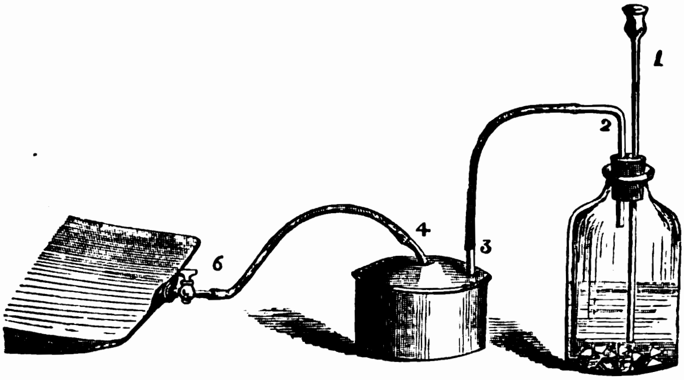


FIG. Hy.

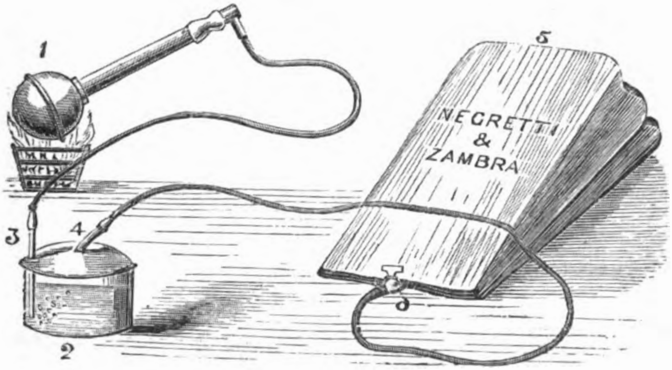
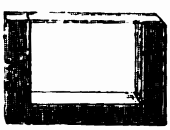


FIG. Oxy.

		Each. £ s. d.	Each. £ s. d.
1600	**Darker's Safety Valves,** for Oxy-Hydrogen Light .		0 5 0
1601	**Oxygen Retort** No. 1 (fig. Oxy.)		0 15 0
1602	Ditto ditto Stout Copper with Vulcanised Rubber Cap and flexible Tube		1 1 0
1603	**Hydrogen Generator,** of Glass or Stoneware . .		0 18 6
1604	**Hydrogen Generator,** stout **Lead,** Nos. 1 and 2 (fig. Hy.)		1 5 0
1605	**Gas Purifier,** Zinc		0 7 6
1606	Ditto **Copper stout,** Nos. 3 and 4 (fig. Oxy.) . . .		0 12 6



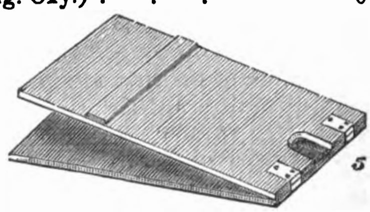


FIG. 1591. FIG. 1609.

1607	**India Rubber Cloth Gas Bags** for Oxy-Calcium light .		2 15 0
1608	**Gas Bags** large and stout, for Oxy-Hydrogen light .		3 10 0
1609	**Pressure Board** (fig. 1609)	1 5 0	1 15 0
1610	**Flexible Vulcanised Rubber Tube** ¼ in. inside, per foot		0 0 8

* Prices for Vulcanized Rubber Goods at present variable.

No.	Article		Each £ s. d.	Each £ s. d.
1611	**Improved Oxydating Lamp Glasses**	per doz.		0 9 0
1612	**Opaque Screens of Oil Cloth,** from 3 to 9 yards square, Made to order.			
1613	**Transparent Screens of all sizes,** by means of which a bright and clear image is obtained—* 8-ft. square, 21s. 10-ft square, 35s. 20-ft. square, 105s.			
1614	**Portable Wood Frames for Screens**	42s.	2 10 0	4 4 0
1615	**Oxygen Gas Mixture,** variable	per lb.		0 1 6
1616	**Best Lime Cylinders**	per bot.	0 3 6	0 5 0
1617	**Magnesium Wire**	per foot		0 0 3
1618	**Lamp,** for burning Magnesium Wire, with Clock-work motion			2 2 0
1619	Ditto ditto with Roller and Reflector			2 10 0

SLIDES FOR DISSOLVING VIEW APPARATUS.

1620 **An Extensive Stock of Painted Views,** adapted either for the single Phantasmagoria Lantern, or Dissolving View Apparatus:—Views in England, Europe, Asia, Africa, and America, &c.; Public Buildings, interior and exterior . . . . . . 7s. 6d., 8s., 10s. 6d., £1 5s.

These paintings differ materially from the common lantern slides requiring first-rate artistic talent to them effective, as, owing to the intensity of the light, the slightest defect is developed. They therefore require the most scrupulous care with regard to the minutest details. *Slides carefully reduced, and Painted from Drawing, &c., to order.* Varying in price according to the subject and size of the painting.

DIORAMIC EFFECTS FOR DISSOLVING VIEW APPARATUS.

FIG. 1730 A.

FIG. 1730 B.

FIG. 1730 C.

These effects are produced by a series of paintings so arranged as to exhibit in an exceedingly pleasing manner the phenomena of day changing into moonlight, a summer landscape changing to a storm, with rain and lightning, which clears away, developing a rainbow, and terminates by winter, with its usual accompaniments of snow, &c. They are arranged in sets of two, four, six, and sometimes ten. We give a list of a few of the most striking. Two prices are quoted, regulated by the quality of the paintings and the amount of fine detail.

The following prices are for circular paintings, 3¼-inch diameter, suited for the 3½ or 4-inch Lanterns. Larger sizes in proportion.

No.	Article	£ s. d.	£ s. d.
1621	**Mount Vesuvius, and the Bay of Naples.**—Three slides, Day and Night, and an Eruption	1 4 0	1 16 0
1622	Ditto ditto.—Three slides, with Rackwork to exhibit the Smoke and Lava in motion		2 16 0

* Prices for these at present, very variable.

		£ s. d.	£ s. d.
1623	**Rustic Scene.**—Three slides, Watermill, Summer, ditto Winter, and Moonlight (figs. A, B, C.)	1 4 0	1 16 0
1624	**Mechanical Slide,** Snow Storm Effect	0 10 6	0 12 6
1625	**Rustic Scene**—Three slides, Watermill in motion, a Swan moving along the water, Summer changing to Winter by moonlight; the clouds move, lights appear in the windows of the mill, with ripples on the water		3 3 0
1626	**Landscape.**—Three slides, Storm, Lightning, and Rainbow effects	1 1 0	1 10 0
1627	**Landscape.**—Summer, Rain, Storm, Lightning, Rainbow, Winter, Snowstorm effects		3 3 0
1628	**Castle of Chillon** by Day and Moonlight, two slides	0 16 0	1 5 0
1629	**The Emigrant Ship.**—Six slides. The Ship leaving Port; at Sea; Full Sail by Moonlight; The Storm; Ship struck by Lightning; Ship on Fire; the Raft with Survivors		2 2 0
1630	Ditto ditto with **Moving Effects**	3 3 0	5 5 0
1631	**Mount Ararat,** with Rainbow effect, two slides		0 16 0
1632	**The Soldier's Dream.**—Two slides	0 16 0	1 5 0
1633	**Arctic Regions.**—Three slides, Mock Sun and Aurora Borealis effects	1 4 0	1 16 0
1634	**Farm House.**—Three slides, Summer, Winter, and Moonlight	1 4 0	1 16 0
1635	**Niagara Falls.**—Two slides with Rainbow, two slides	0 12 6	0 15 6
1636	**St. Peter's, Rome.**—Three slides, Day and Night, with Fireworks from the Tower of St. Angelo	1 4 0	2 2 0
1637	**Interior** of ditto.—Two slides ditto ditto, with effects		1 8 0
1638	**The Old Royal Exchange** by Day, by Night on Fire, and the present Royal Exchange, three slides	1 16 0	2 2 0
1639	**A Storm at Sea** and the Life Boat	0 16 0	1 5 0
1640	**Mount Hecla,** with Lava and Smoke in motion, two slides		1 12 0
1641	**The Magician's Cave** and effect		1 10 0
1642	**The Magic Mirror.**—Two slides and effect		1 10 0
1643	**Faust and Mephistophiles,** with effect, Vision of Marguerite, two slides		1 10 0
1644	**Mosque of Omar.**—Two slides, Day and Night effect		0 16 0
1645	**The Serenade.**—Moonlight Scene, with Gondola	0 14 0	1 5 0
1646	**The Angel's Whisper.**—Two slides		1 5 0
1647	**A Swiss Pass.**—Summer, Moonlight, and Winter		1 4 0
1648	**London.**—St. Paul's and the Thames, Day and Night		1 5 0
1649	**Virginia Water,** Moving Swan and Night effect, three slides		1 10 0
1650	**Old London in 1666,** Day View, and the great Fire, with Rackwork effect, Smoke and Flames, three slides		2 2 0
1651	**The Port of Alexandria,** with Shipping in motion, Smoke, Moonlight, and ripple on the Water		1 10 0
1652	**Esquimaux Village.**—Snow Huts, with Aurora, &c., three slides		1 1 0
1653	**Destruction of Pompeii,** with Rackwork effect, Smoke and Ashes		1 10 0

		£ s. d.	£ s. d.
1654	**The Overland Route.**—A series of twelve views, each view	0 8 0	0 12 0
1655	**Mount Blanc.**—A series of eighteen views. The Ascent from Geneva to the Summit, and the Descent to Chamouni, each view	0 8 0	0 12 0
1656	**The Arctic Regions.**—A series of twelve views, each view	0 8 0	0 12 0
1657	**Natural Phenomena.**—A series of eighteen slides, each view	0 8 0	0 12 0
1658	**The Bottle.**—Eight slides, each view	0 10 6	0 12 0

Nos. 1761 and 1762 and 1764 may be rendered extremely interesting by the addition of a few coloured or plain Photographic Slides of Continental and other Cities, &c.

		£ s. d.	£ s. d.
1659	**The Drunkard's Children.**—A series of views, each view	0 10 6	0 12 0
1660	**The Pilgrim's Progress.**—A series of twelve or twenty-four views	0 10 6	0 12 6
1661	**Hogarth's Idle and Industrious Apprentice,** ten slides		6 6 0
1662	**A Journey Round the World.**—All the most remarkable and interesting views in the four quarters of the globe, each slide	0 8 0	0 12 6

Nos. 1654, 1655, 1656, 1657. These series can be extended to thirty-one views each; No. 1661 will be painted specially to order.

IN THE PRESS, by NEGRETTI & ZAMBRA, New and Revised Edition, Illustrated with Wood Engravings.

THE MAGIC LANTERN, DISSOLVING VIEWS,

AND

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THEIR HISTORY AND CONSTRUCTION;

ALSO

DIRECTIONS FOR USE,

WITH OIL LAMPS, OXY-CALCIUM AND OXY-HYDROGEN LIGHT,

AND

INSTRUCTIONS FOR PAINTING ON GLASS.

SPECTRAL EFFECTS,

GHOSTS DESCRIBED, AND HOW TO PRODUCE THEM.

FIFTH EDITION. PRICE (POST FREE) ONE SHILLING.

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TRANSPARENT PHOTOGRAPHIC VIEWS AND STATUES

PRINTED ON ALBUMEN,†

FOR EITHER MAGIC LANTERNS OR DISSOLVING VIEWS,

BY

NEGRETTI AND ZAMBRA.

The award of the only PRIZE MEDAL by the Jury of the International Exhibition of 1862, and the Austrian Gold Medal, to NEGRETTI & ZAMBRA'S Photographic Transparencies, sufficiently stamps their value as aids in the advancement of Science and Education, without further comment.

The following extract from CHAMBERS' JOURNAL will describe these Photographs exhibited by the Lantern:—

"Unquestionably, however, the most important use which has yet been made of this new process (illuminated dissolving Photographs) was the exhibition through the whole of last winter, at the Manchester Mechanics' Institution of a series of Egyptian Photographs. The most remarkable feature of this series of pictures was the *solidity* and *reality* with which they were invested, which were almost sufficient to cheat the beholder into the belief that, by some optical glamour, he was transported bodily to the mystical banks of the Nile. Most of us are familiar with these scenes through the medium of David Roberts' paintings; but whilst we willingly pay them the tribute of our admiration, gratefully remembering the pleasant hours we have spent in studying them, we must admit that they fall short of producing the interest and effect which result from Photographs of the same scene shown in this manner."

Negretti and Zambra's Photographic Lantern Slides now include views of all the most remarkable places in every part of the Globe, Photographic Statues, &c., &c. The following list comprises a few of the most interesting subjects:—

REDUCED PRICES.

1663 **Price of Negretti and Zambra's Photographic Views,** printed with **Albumen**, uncoloured, mounted in Frame each, Plain, 0 3 3 Coloured, 0 7 6

1664 **Negretti and Zambra's Photographic Statues,** in Frame 0 3 3

LIST OF STATUES

PHOTOGRAPHICALLY PRINTED ON ALBUMEN.

1665 CRYSTAL PALACE SERIES.

3 A Nymph preparing for the bath
3C Apollo discharging his bow
4 The Tired Hunter
4C Eve Listening
5 Una and the Lion
5A Dorothea
6A Jane Shore
6B Maid of Saragossa
7 Andromeda
7* A Naiad
9 Mercury
10 Flora
11 Boy with Tambourine
12* Venus
13 Venus Vincitrice
14 Flora
16 The Laocoon
17 Minerva of Farnese
18 Aurora
19 Demosthenes
22 Diana
27 Ariadne
28 Minerva
31 Posidippus
32 Neranda

† Messrs. Negretti and Zambra beg to caution purchasers of Photographic Slides against pictures printed with Collodion, as definition and clearness, fit for exhibition, are only to be obtained from Albumen prints.

33* Children and Pony
34 The Emigrant
37 Samson
37* Minerva
38 Musidora
39 The Massacre of the Innocents.
40 Milo
40* Minerva
41 Satan
42 Ariel
44* David
46 The Mourners
47 Andromeda
47* The Borchesse Flora
48 Ulysses
49 The First Whisper of Love
51 Sabrina
52 Zephyr and Aurora
53 Geoffrey Chaucer
54 A Nymph of Diana
55 Mercury
56 Shakspeare
57 Lavinia
58 Highland Mary
62A Diana
92C Night
62D Morning
63 Æsculapius
64 Psyche
64* Pomona
66 A Fawn with Cymbals
67 Angel watching
67* David
68 Venus and Cupid
75 Diana
78 Cupid and Psyche
79 Thalia
80 Zephyr wooing Flora
80* Augustus
80A A Roman
81 Apollo
81* A Victory
82 Penelope
83 Venus at the Bath
83* A Bacchante
84 A Victory
85 Penelope and Telemachus
89 Bacchus
90 Æsculapius
91* A Hunter
92 Julian the Apostate
93 The Three Fates
94 The Chase
96 The First Cradle
98 A Neapolitan Dancer
99 A Neapolitan Improvisatore
100 Cain

101 A Bather
102 Milo of Crotona
115 Eurydice
115** Night
115* Charity
116 Venus disarming Cupid
121 Charity
120-29* Pudicita
130 Ceres
131 Venus leaving the Bath
135 Mars and Venus
155 Hope
138 Magdalen
152 The Murder of the Innocents
142* A Vestal Virgin
146 David
147 A Girl Knitting
148 First Steps
149 Italy
150 Veritas
150* Eve
152 Melancholy
156 Esmeralda
160 Ishmael
162 Minerva protecting a Warrior
163 A Child Christ
155-65* Juno
167 A Nymph
168 A Girl bearing Fruit
169 A Vase
170 Pomona
171 Medicine
171A Maria F. Malibran
176 Homer
177 Thucydides
178 Guardian Angel
185-7-8 A Victory
191 An Eagle
195 Priest of Bacchus
196 A Pieta
196* Melpomene
201 Madonna of Munich
201* A Violin Player
201 Iris Hecate of Lucifera
202 A Nymph
204 Ceres and Proserpine
208 Angel
212 A Knight
223 Love
224 Venus
229 Julia
230 Musician
231 Victory
232 A Youth
233B Voltaire
234 Camillus

239 Urania
250 Psyche
251 Belvidere Apollo
253 Eros
255 Ariadne
259 Iphigenia
261-270 Diana
262 Hagar
263 A Hunter
264 Hunter defending his family
265 Abraham Duquesne
267 A Neriad
269 Winter
271 A Flower Girl
279A Chateaubriand
286 Trajan
295 A Fawn
308A Louis XIV.
313 Peter Paul Rubens
314 Antinous
321 Demosthenes
327 Zeno
385 Gottold Ephraim Lessing
251 Pallas
358 Cupid encircled by a Dolphin
362 Venus di Medici
367 A Fawn
374 Urania
407 Shakspeare
412* William Wordsworth
431 Humphrey Chetham
449 Earl of Chatham
0-1 Massacre of the Innocents
0-2 Mattabus and Camilla
0-3 Aurora
0-4 Sleeping Children
0-5 Godiva
0-6 Ajax praying for Light
0-7 A Girl with Triangle
0-8 Music's Martyr
0-9 The Pieta; by Bermine
0-10 The Minstrel
0-11 Michael Angelo
0-12 Jonah
0-13, 0-14, 0-15 Virgin and Child
0-16 Marriage of Virgin
0-17 Girl with Pet Bird
0-19 Bas Relief—The Last Supper
0-20 Bas-Relief—The Adoration of the Magi
0-21 Bas Relief—Virgin and Child
0-23 St. George
0-24 John Bunyan
0-25 St. Andrew
0-26 St. John

Virginius
Jason
A Day Dream
The Dying Gladiator
Eve at the Fountain

Love Triumphant
Europa
Toilet of Atalanta
Titania
The Greek Slave

Wrestlers
Ancient Briton
A Warrior
The Son of Niobe
Salmacis.

1666. LIST OF VIEWS IN EGYPT AND NUBIA,

Photographically Printed on Albumen.

300-2-28 Views of the Temple of Dendera
301 The Granite Quarries of Syene
300-4 The Rock Temple of Derr, the chief town in Nubia
305 The Rock of Abouseer and the second Cataract
306 Kalet Adde, a ruined Sar .cenic town
307-9 The Façade of the Great Rock Temple at Aboo-Simbel in Nubia
310 The smaller Rock Temple of Aboo-Simbel, time of Rameses the Great, B.C. 1400
311 Girgeh, Upper Egypt
312 The Temple of Amada near Derr
313, 314 The Temple of Waddy Saboda
315-317 The Temple of Dacke, founded by Ergamun, about 2000 years ago
316 Temples at Makarraka in Nubia
318-19 The Portico of the Rock Temple of Gerf Hossayn or Gyrche
820 The Temple of Dendoor, built in the reign of Augustus Cæsar
321-2-3-4 The Temple of Kalabshee, Nubia
325 Traveller's Nile boat or "Dahabeeh"
326-7 Wady Kardassy in Nubia
229-30-31 Views in the Island of Philæ
333-4 The Principal Court of the Large Temple at Philæ
335 Crocodile on a sand bank in the Nile
336 Principal Corridor of the Island of Philæ
337-8 Views from the Island of Philæ
339-41-42 Hypæthral Temple at Philæ, usually called "Pharaoh's Bed"
340 View between the upper portions of the Two Principal Pylons at Philæ
343 View of an Arab Village and ruins, Island of Biggeh, opposite Philæ
334 Ruined Mosque of Mishdd, with distant view of Philæ
345 Remarkable Granite Formation between the first Cataract and Philæ
346 The River Wall and South End of Philæ
347 North Approach to Philæ
348 Assouan, Upper Egypt
349-88 The Sphinx and Great Pyramid at Geezeh
350-51 The Temple at Kom-Ombo
352-3-4 Grottoes and Rock Cuttings in the Sandstone Quarries at Hagar Silisili
355-56 Temple of Edfou, Greek Period
357-8 The Temple of Erment, near Thebes
359-60-61 Views of Luxor
362-3 The Approach to Karnak, the Avenue of Sphinxes, and the Ptolemaic Pylon
364-6-7 The principal Ruins of Karnak
365 General View of Karnak
368-9 The Two Obelisks, and part of the Hall of Columns, at Karnak
370 Remains of the Granite Pylon and two Colossi at Karnak
371-95-6-7-8-9 Six views of the tombs of the Memlook Kings at Cairo
372-3-4-93-4 Views of Portions of the Great Hall of Columns at Karnak
372 Rock Tombs under the Great Pyramid at Geezeh
376-89 The Two large Pyramids at Geezeh
377 The Colossi of the Plain, the celebrated Statues of Memnon, at Thebes
378 The Temple Palace of Goorneh, at Thebes, commenced by Sethos, some 3000 years ago
379-80-01 The Memnonium at Thebes
382-3-4-5-6 Medeenet Haboo, the Temple Palace of Rameses III. at Thebes, about 1300 B.C.
387 The Valley of the Tombs of the Kings, at Thebes
390-91 The Entrance to the Great Temple at Luxor
392 The Court of Sheshonk (the Shishak of the Scriptures) at Karnak

1667. HOLY LAND.

400 Gaza. The Modern Town
400D Gaza. The Old Town
401 Samson's Gateway. (Gaza)
402-3 Ramleh, the ancient Arimathæa
404 Village of Aboo Gosh, Kuriat el Enab, the ancient Kirjath Jearim
405-6 Jerusalem from the Mount of Olives
407 Jerusalem. Pool of Bethesda
408 Jerusalem. Church of St. Anne
439 Jerusalem, from the north-east corner of the present city
410 En Rogel; or, the fountain-head of Rogel
411 Jerusalem, from fortification on Sion
412 Jerusalem, from the south part of the city wall
413 Jerusalem, from the chief tower of the citadel
414 Jerusalem. View from the south wall on Mount Sion
415 Jerusalem. View taken within the present city
416 Tomb of Absalom, at the foot of the Mount of Olives
417 Jerusalem, from the south-east
418 Jerusalem, from the top of the Mount of Olives
419-20 Jerusalem, from the top of the citadel
421 Jerusalem, English Protestant Church
422 Jerusalem, from the Mount of Olives
423 Tomb of Rachel, from the north-north-east
424 Bethany, from the south
425 Bethlehem, from the north-east
426 Hebron. Southern half of the city
427 Hebron, the Pool of David

428 Hebron. Northern half of the city
429 The Dead Sea, seen from its northern shore, looking west-south-west
430 Monastery of St. Saba
431-2-3-4 Banias, the ancient Paneas and Cæsarea Philippi
435 The Ford of the Jordan, the site of the Baptism
436 Distant View of Damascus
437 The Old Wall of Damascus
438 Damascus. The East Gate
439 Panorama of Damascus, looking west
440 Panorama of Damascus, looking south-west
441 Panorama of Damascus, looking east
442 Damascus, Roman gateway and street view
443 Nazareth, from the south-east
444 Nazareth from the north-west
445-6 Nablous (ancient Sichem or Sechem)
447 Nablous, seen from the south-west; Mount Ebal is seen to the left, and Mount Gerizim to the right
447D Sebustieh, the ancient Samaria
448 Tiberias, seen from the south, on the shore of the lake
449-50 Baalbec, the ancient Heliopolis, or City of the Sun. The Six Great Columns and the smaller Temple
451-52 Baalbec. View from the north-west and the south-east
453 Baalbec. The Temple proper
454 Baalbec. Octagon Temple
455-6-7 Cedars of Lebanon

1668 SECOND SERIES OF EGYPT AND HOLY LAND.

458 Cairo. Group of Tombs and Citadel, from the Mukattan Hills
459 Cairo. Ruined Mosques, with Cufic writing, on the Mukattan hills
460-61-64 Cairo. The Mosque of Sultan el Hakem
462-65-90 Cairo from the citadel
463 Cairo. Gateway of the Ruined Palace of the Grand Vizier, and Mosque of ditto
466-91 Cairo. The Mosques of Mardani and Sultan Hassan, City Walls and General View, looking south-west
467-8 Cairo. Modern Painted Tombs, near Cairo,—Tombs of the Caliphs in the distance
469 Boulac. The Port of Cairo
470-74 Cairo. Tombs of the Caliphs
471-72 Cairo. Street Scene on the Way to the Citadel
473-75 Cairo. Gateway of the Citadel
466 Cairo. View in the Roumaleah Square, and Mosque of Mahmoudieh, with Camels.
477-8-9 Belzoni's Pyramid at Geezeh
480-82-85½ The Pyramids of Dashour
481 Arab Sportsman and Cook
483 The Pyramids of Sakkara
484 The Three Pyramids of Geezeh
485 Cairo. The Bab-el-Nasr, or Gate of Victory
486-7-8 Cairo. Tombs of the Mamelukes
489 The Mosque of Emeer Akoór
492 Cairo. From the Citadel Fort, with distant View of the Tombs of the Caliphs
493 Cairo. View from the Citadel Fort
494 Camels and Prickly-pear Orchard
495 Suez, on the Red Sea
496 Peninsula of Sinai. The Wady Bahala
497 Peninsula of Sinai. Sculptured Stones at Sirabit-el-Rhadem
498-9 Peninsula of Sinai. The Wady Mukatteb, or Written Valley, and Sinaitic Inscriptions in this Wady
500-1-2-3 Peninsula of Sinai. View of Mount Serbul from Wady Feiran
504-5 Peninsula of Sinai. View in the Wady Feiran
506-7 Peninsula of Sinai. The Convent of Sinai, and the distant plain of El-Raheh
508-9 Peninsula of Sinai. Bird's-eye View of the Convent of Mount Sinai
510-11 Peninsula of Sinai. Mount Sinai (Horeb) with the Convent. From the Plain of El-Raheh (the Place of the Assemblage)
512 Peninsula of Sinai. Gebel Mousa (Sinai) from the Wady-es-Sebaiyeh
513 The Island of Grayia
514 Jerusalem. Façade at the Church of the Holy Sepulchre
515 Jerusalem. Street in Jerusalem, with Church of the Holy Sepulchre
516 Jerusalem. The Village of Siloam, and Valley of Kidron
517 Jerusalem. Ancient Tombs in Valley of Jehoshaphat
518 Jerusalem from Mount Scopus
519 20-21-22 Jerusalem from the Mount of Olives
523 Mount of Olives. The Church of the Ascension

1669 SCRIPTURE SCENES. Price 7s. 6d. each, Coloured.

Adam and Eve in Eden
The Expulsion from Paradise
Cain and Abel
Adam finding Abel
Noah sending the Dove from the Ark
Sending away of Hagar and Ishmael
Hagar and Ishmael in the Desert
Sacrifice of Isaac
Jacob and Laban
Jacob's Dream
Rebecca at the Well
Departure of Rebecca
Arrival of Rebecca
Joseph sold by his Brethren
Joseph interpreting Pharaoh's Dream
Worship of the Golden Calf
Pharaoh's Daughter finding Moses
Moses striking the Rock
The Brazen Serpent
The Angel appearing to Balaam
Samuel and Eli
Samuel praying
David with the Head of Goliath
Mordecai's Triumph
Daniel in the Den of Lions
The Handwriting on the Wall
The Angels appearing to the Shepherds
The Nativity
The Adoration of the Magi
The Flight into Egypt
The Murder of the Innocents
Christ in the Temple
The Holy Family
The Baptism of Christ
Christ at the Well
Christ healing the Sick and Blind
Christ blessing Children
The Miracle at Cana
Christ weeping over Jerusalem
Christ's Entry into Jerusalem
Mary Anointing Jesus's feet
Christ Raising Lazarus
Christ Walking on the Sea
The Prodigal Son in want
The Return of the Prodigal
The Good Shepherd
The Vineyard—Hiring the Labourers
The Husbandmen and the Heir
The Unjust Steward
Behold the Lilies
Dives, the Rich Man
The Wise and Foolish Virgins (two of this)
The Good Samaritan
The Widow's Mite
The Last Supper
Christ before Pilate
Ecce Homo
The Crown of Thorns
Christ bearing His Cross
The Crucifixion
The Descent from the Cross
Mary at the Sepulchre
The Ascension
Stoning of Stephen
The Angel releasing Peter from Prison
Conversion of St. Paul
Paul Preaching at Athens

1670 CHINA AND THE CHINESE: Price 7s. 6d. each, Coloured.

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The Great Wall
The Harbour of Hong Kong
Chinese Boatmen
Ditto ditto fighting Quails
Chinese Dice Players
Feeding Silk Worms
Winding the Cocoons
Pavilion of a Mandarin
Chinese Kite Flying
Itinerant Doctor and Barber
A Raree Show
A Street in Canton
Chinese Lantern Maker
Chinese Ladies playing at Cards
Chinese Joss House
Chinese Cap-maker's Shop
Bamboo Aqueduct
Western Gate, Pekin
The Nine-storied Pagoda
The Five-storied ditto

1671 London: Price in Frames 3s. 3d. Plain, and 7s. 6d. each, Coloured.

Panorama of London
The Marble Arch
Buckingham Palace
Westminster Abbey
Houses of Parliament
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The British Museum
Temple Bar
Waterloo Bridge
Somerset House
St. Paul's
Guildhall
The Post Office
The Bank
The Royal Exchange
The Monument
London Bridge
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The Trinity House
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The Albert Memorial

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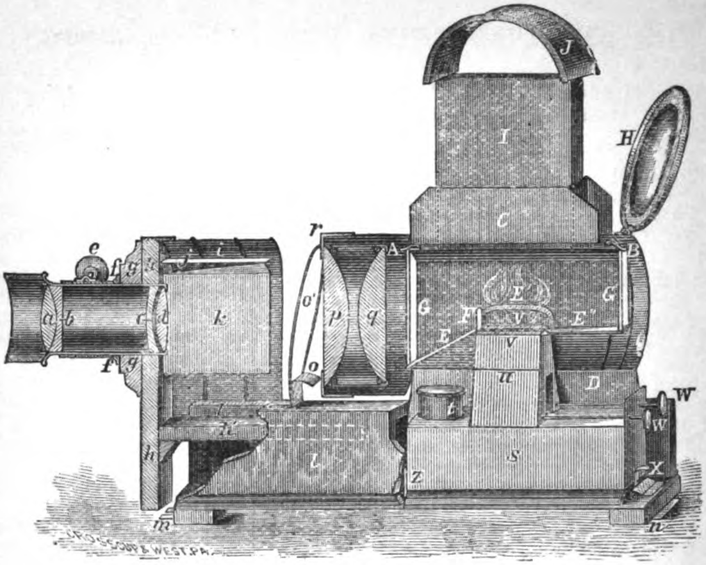

FIG. 1674.

Fig. 1647 is a *novel arrangement of both Lantern and Lamp,* named by its inventor *Sciopticon.* The principal novelty of the Sciopticon is a curiously contrived Paraffin Lamp, with its ridge of wide intensified double flame lying edgewise to the lenses, giving out great illuminating power.

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A pair of **Sciopticons** with arrangements for **Dissolving Views**, the Box or Packing Case with the legs forming a **Stand** for the Lanterns. £14 14 0

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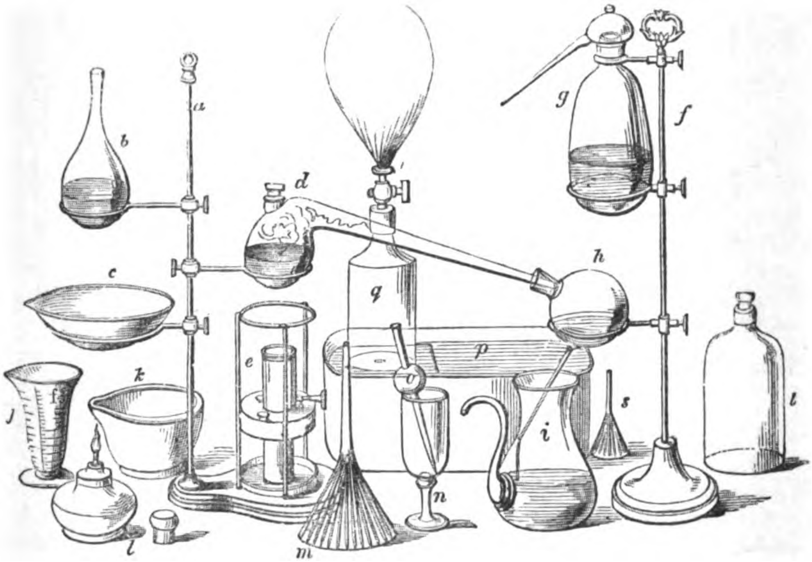
1676 **Varnish,** prepared for ditto, 1s. 6d. per bottle.

These Lists comprise only a very small portion of Negretti and Zambra's Photographic Series that can be conveniently detailed within the limits of a Catalogue.

Engravings, Drawings, Maps, &c., copied by Photography for Projection by the Lantern.

CHEMICAL APPARATUS.



GLASS, PORCELAIN, EARTHENWARE, &c.

FIG. 1677.

FIG. 1678.

		Each. £ s. d.	Each. £ s. d.
1677	**Adapters** for connecting retorts to receiver, small tube, straight, 8 oz. and 16 oz. (fig. 1677)	0 0 9	0 0 10
1678	Ditto ditto, bent, 8 oz. and 16 oz. (fig. 1678) . .	0 0 10	0 1 0
1679	**Adapters,** full size, for large operations . . various		
1680	**Air Jar Tubes,** for experiments on the gases :—		

Long .	2-in.	3-in.	4-in.	6-in.	6-in.
Width .	½-in.	⅝-in.	⅝-in.	¾-in.	1-in.
Price .	3d.	4d.	6d.	9d.	10d.

		Each. £ s. d.	Each. £ s. d.
1681	**Air Jar Tubes,** cylindrical, per nest of six . . .	0 8 6	0 10 6
1682	**Air or Gas Jars,** stout bell glass, with ground edges—		

		½-in.	pts.	qts.	3 pts.	4 pts.
1683	Narrow Mouth, plain (fig. *t*) .	1s. 3d.	2s.	3s.	4s. 6d.	6s.

		½ pts.	pts.	qts.	3 pts.	4 pts.
1684	**Air or Gas Jars,** Stoppered (*t*)	2s.	3s.	4s.	5s.	7s.
1685	Ditto ditto mounted with Brass Cap	2s. 6d.	3s. 6d.	5s. 6d.	6s. 6d.	8s. 6d.

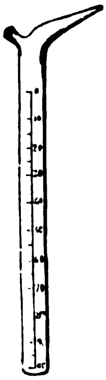


FIG. 1690.

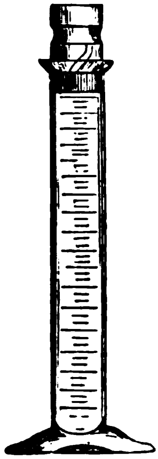


FIG. 1693.

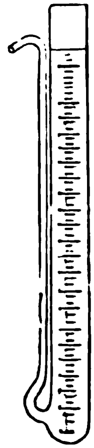


FIG. 1692.

No.	Article	Each. £ s. d.	Each. £ s. d.
1686	**Air or Gas Jars,** Wide Mouth, Plain 1s. 6d. 2s. 6d.	4s. 5s.	7s. 6d.
1687	Ditto, ditto Stoppered 2s. 6d. 3s. 6d.	5s. 6s.	8s. 6d.
1688	**Air or Gas Jars,** mounted with Brass cap, two Stop-cocks, Connecting-piece, and Bladder Ferrule from		0 18 0
1689	**Air or Gas Jars,** graduated into Cubic Inches and Decimal parts, for mixing gases, Capped or Stoppered from		0 5 0
1690	**Alkalimetres or Chlorimetres,** Binks' form (fig. 1690) .		0 5 6
1691	Ditto ditto, with Foot (fig. 1691)		0 6 6
1692	Ditto Gay Lussac's (fig. 1692)		0 5 6
1693	Ditto old form (fig. 1693)		0 6 0
1694	**Schuster's Alkalimeter** (fig. 1694)		0 2 0
1695	**Alkalimetre,** 1000 grains, divided into 100 parts of equal capacity, for Volumetric Analysis (figs. 1695, and 1695*)	0 6 6	0 8 6

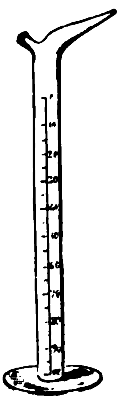


FIG. 1691.

FIG. 1694.

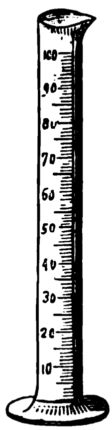


FIG. 1695.

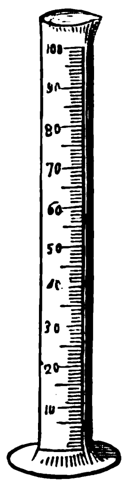


FIG. 1695*.

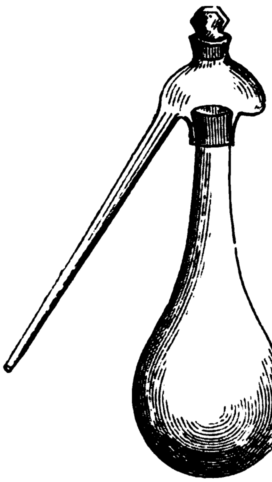
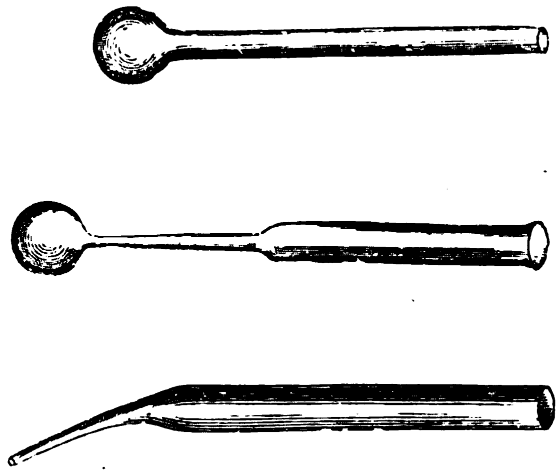


FIG. 1696.



FIGS. 1699.

		Each. £ s. d.	Each. £ s. d.
1696	**Alembics**—		
1697	**Alembics** of German Glass, 4 oz. and 6 oz. capacity, for experimental distillations		0 2 6
1698	**Alembics**, Berlin ware, with moveable head, for distillation of substances at very high temperatures .		0 12 6
1699	**Arsenic Tubes**, of hard German glass, Berzelius', Clark's, Liebig's, or Rose's form (fig. 1699) per doz.		0 1 6
1700	**Aspirators**, Glass, see Water Bottles.		
1701	**Barometer Standard**, for Laboratory use, entirely of Glass, Guy Lussac's syphon form, the scale divided on the tube either inches or millimetres . . .	3 3 0	5 5 0

1696 Alembics—

	4 oz.	8 oz.	16 oz.	qrt.
Earthenware	2s. 6d.	3s. 6d.	4s. 6d.	6s. 6d.
Glass (fig. 1696) . .	6s. 6d.	7s. 6d.	12s.	14s.

See ante, page 11.

1702 **Basins, Evaporating,** of Berlin ware, flat bottoms, with spout, shallow form; depth, one-fourth the diameter:—

Contents .	1-oz.	2-oz.	3½-oz.	5-oz.	8-oz.	12-oz.	18-oz.
Price .	9d.	10d.	1s.	1s. 3d.	1s. 6d.	2s.	2s. 6d.

1703 **Basins**, Berlin Porcelain, small and thin, for Analytical Experiments, uniform in substance:—

Contents .	⅛-oz.	¼-oz.	½-oz.	1-oz.	1½-oz.	2-oz.
Price .	3d.	5d.	6d.	8d.	10d.	1s.

1704 **Beaker Glasses** (fig. 1704), Cylindrical form, the glass uniformly thin and well annealed, of German manufacture:

Sets of	3	5	8	12
Price	2s.	3s.	5s. 6d.	11s. 6d.

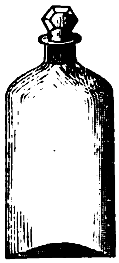


FIG. 1706.

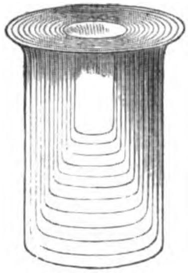


FIG. 1704.


FIG. 1705.


FIG. 1713.

No.	Description	Each. £ s. d.	Each. £ s. d.
1705	**Beaker Tumblers**, with spout, for hot solutions, &c.; being shorter, are easier cleaned than beakers, and precipitates more easily removed. In sets of six (fig. 1705)		0 6 0
1706	**Bottles**, best Flint glass, London Stoppered (fig. 1706):—		
	¼-oz., ½-oz., and 1 oz., narrow mouth, per doz. 4s. wide mouth per doz.		0 5 0
	2-oz. . . . „ „ 5s. „ „		0 6 0
	3-oz. . . . . „ „ 6s. „ „		0 7 0
	4-oz. . . . . „ „ 7s. „ „		0 8 6
	6-oz. . . . . „ „ 8s. „ „		0 9 6
	8-oz. . . . . „ „ 9s. 6d. „ „		0 10 6
	10-oz. . . . . „ „ 10s. 6d. „ „		0 11 6
	16-oz. . . . . „ „ 11s. 6d. „ „		0 13 0
	20-oz. . . . . „ „ 13s. 6d. „ „		0 15 0
1707	**Bottles**, Green glass, Stoppered:—		
	¼-pint, narrow mouth, per doz. 5s. wide mouth, per doz.		0 6 0
	½-pint „ „ 5s. 6d. „ „		0 6 6
	1-pint „ „ 6s. „ „		0 7 6
	2-pint „ „ 7s. „ „		0 11 0
1708	**Bottles**, Acid, with elongated stoppers . . from		0 1 6
1709	Ditto, **Capped**, for Æther, &c. 1-oz. 2s.; 2-oz. 2s. 6d.; 4-oz. 3s.; 8-oz. 3s. 6d.		
1710	Ditto, Capped, and fitted into turned wood boxes, various, from		0 1 6
1711	**Bottles**, small Tube, for containing rare specimens, plain, ... per doz.		0 2 0
1712	Ditto ditto, Stoppered		0 8 0
1713	**Bottles**, washing, Gmelin's (fig. 1713) . . from		0 1 6
1714	Ditto ditto, with Handle, for hot water, &c. . .		0 4 0
1715	**Capsules**, glass	0 0 3	0 0 6
1716	**Capsules**, of Berlin Porcelain, with spout and handle, very light:—		

Contents	1-oz.	2½-oz.	4-oz.
Price	10d.	1s.	1s. 2d.

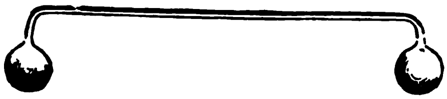


FIG. 1735.

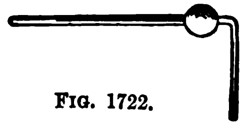


FIG. 1722.

FIG. 1722.

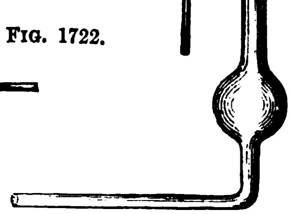
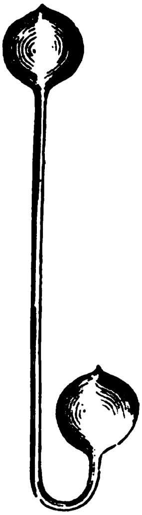
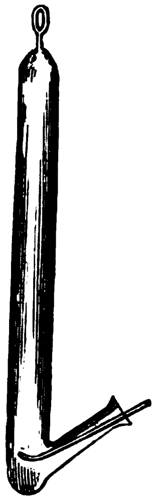
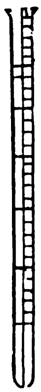
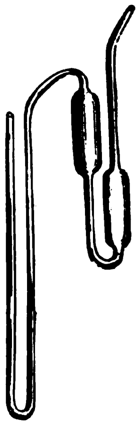


FIG. 1719.









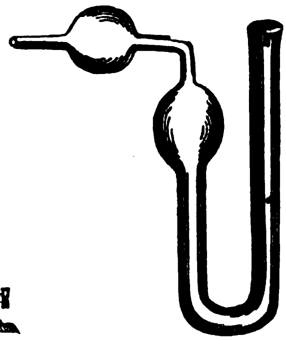


FIG. 1735*. FIG. 1733. FIG. 1726. FIG. 1744. FIG. 1741. FIG. 1723.

No.	Article	Each. £	s.	d.	Each. £	s.	d.
1717	**Bulb Tubes** for weighing Oxide of copper . each				0	0	8
1718	**Brunner's Aspirator,** consisting of a Glass Bottle, one gallon capacity, with tap (fig. 1885)				1	4	0
	For other sizes of this useful article, see Water Bottles.						
1719	**Connecting Tube,** Bent (fig. 1719) . . . . each				0	1	0
1720	**Combustion Tube** of Hard German Glass, very infusible . . . . per lb.				0	3	0
1721	**Combustion Tubes** prepared from the above Glass per doz.				0	10	0
1722	**Chloride of Calcium Tubes,** for absorbing moisture from gases, with straight or bent point (figs. 1722) each				0	0	6
1723	Ditto ditto U shaped, with two bulbs (fig. 1723) .				0	1	6
1724	**Crucibles, real Hessian,** triangular shape, in nests :—						
	Nest of 3 Crucibles, Nos. 2 to 4				0	0	6
	„ 5 „ 1 to 5				0	1	0
	„ 6 „ 1 to 6				0	1	6
	„ 8 „ 1 to 8				0	2	6

1725 **Crucibles, London Made, Fire-Clay,** round form, capable of resisting high temperatures : —

Height, without covers	3-in.	4-in.	4½-in.	5-in.	6-in.	7-in.	8-in.
Price . . .	2d.	2½d.	3d.	4d.	5d.	8d.	1s.

Covers at the same prices as the Crucibles.

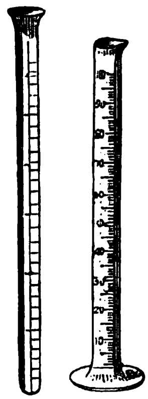


Fig. 1726. Fig. 1727.

No.	Article	Each. £ s. d.	Each. £ s. d.
1726	**Crucible Cases, or Jackets and Covers,** of fire-clay, toprotect platinum crucibles, and raise them to where the heat is the most intense	0 1 0	0 1 6
1727	**Crucibles,** Wedgwood Ware	0 0 8	0 1 0
1728	Ditto, Skittle shaped 3 to 12 inches high, from	0 0 4	0 1 6
1729	*Ditto, Round, with Covers . . .		0 1 6
1730	Ditto, Berlin Porcelain, various from		0 0 6
1731	Ditto ditto, not glazed, with perforated covers	0 0 8	0 1 8
1732	**Calcining Pots,** to open in the middle .	0 0 6	0 2 0
1733	**Cooper's Receiver,** for collecting Gases over mercury (fig. 1733) . . .		0 1 6
1734	Ditto ditto, Graduated		0 7 6
1735	**Cryophorous,** Wollaston's, or Frost Bearer (figs. 1735 and 1735*) . . . , . .		0 4 6
1726	**Cubic Inch Tubes,** graduated into 10ths and 100ths (fig. 1726)		0 4 0
1727	Ditto ditto on Round Foot (fig. 1727) . . .		0 6 0
1728	**Cubic Inch Bottles,** (see Specific Gravity Bottles.)		

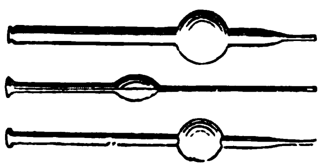


Fig. 1738.

Fig. 1740.

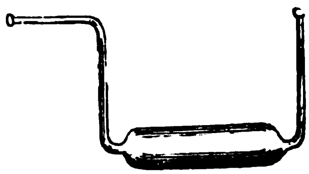
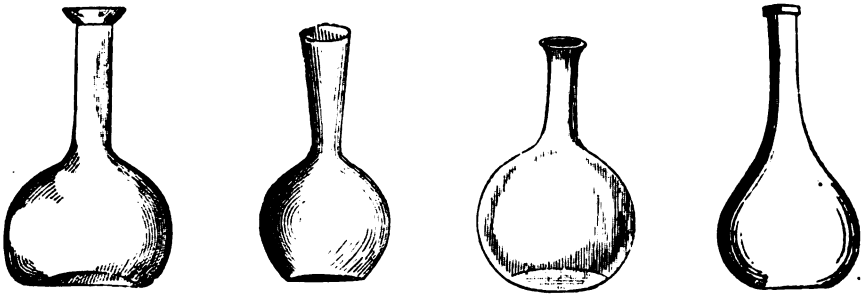


Fig. 1729.

No.	Article	Each. £ s. d.	Each. £ s. d.
1729	**Drying Tube,** (fig. 1729) a bent tube in which substances to be analysed are placed to dry them, each		0 1 6
1730	**Drainers for Crystals,** porcelain		0 2 6
1731	Ditto ditto shallow form		0 2 0
1732	**Deflagrating Jars** (see Gas Receivers)		
1733	**Dishes,** Glass, various shapes . . . . from		0 2 6
1734	Ditto, Evaporating, Berlin ware, various.		
1735	**Dishes,** Evaporating, Wedgwood ware, not liable to stain or crack :—		

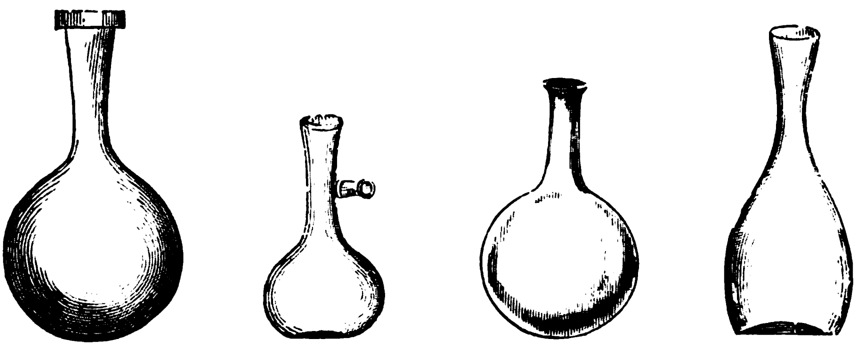
Diameter .	2 in.	3 in.	4 in.	5 in.	6 in.	7 in.
Price	. 4d.	6d	9d.	1s.	1s. 4d.	1s. 8d.
Diameter .	.	8 in.	9 in.	10 in.	11 in.	12 in.
Price .	. .	2s.	2s. 6d.	3s.	3s. 9d.	4s. 6d.

No.	Article	Each. £ s. d.	Each. £ s. d.
1736	**Dishes,** Sulphuric Acid, for desiccating purposes . .		0 5 0
1737	Ditto, **Washing,** flat Porcelain (see Photographic Apparatus).		
1738	**Dropping Tubes,** or Pipettes (fig. 1738) 4d., 6d., and		0 0 8
1739	Ditto ditto Graduated to grains, &c.	0 3 0	0 7 6
1740	**Dropping Bottles** (as fig. 1740)	0 2 0	0 2 6
1741	**Desiccating Jars,** for drying gases by the aid of Chloride of Calcium (fig. 1741)		0 11 0



FIGS. 1753.

No.	Article	Each. £ s. d.	Each. £ s. d.
1742	**Desiccating Tubes,** with one bulb, and the end straight or bent (fig. 1722)		0 0 6
1743	**Evaporating Dishes** (see Dishes).		
1744	**Ettling's Gas Transferrers,** various forms (fig. 1744) .		0 3 6
1745	**Eudiometer, Volta's,** graduated to 200 divisions=2 cubic inches (figs. 1745 and 1745*)	0 7 6	0 12 6
1746	**Eudiometer, Ure's U-shape** (fig. 1746), graduated to 200 divisions=2 cubic inches		0 10 6
1747	**Flasks,** Florence		0 0 4
1748	**Flasks,** White Flint Glass wide and narrow mouthed, with round and flat bottoms, from 1-oz. to 1-qt.. from	0 0 4 to	0 4 0
1749	**Flasks,** with Side Neck, for Fractional Distillation, (fig. 1753*) . . . . . 1 pint, 2s. 3d., 2 pints,		0 4 6
1750	**Flasks,** very light, mounted with **Brass Stop-Cock** for weighing gases		0 10 6
1751	**Flasks,** Graduated to hold 1 Pint Imperial . . .		0 3 6
1752	**Flasks,** Graduated to hold exact quantities—Grains, Cubic Inches, or Cubic Centimetres	0 2 6	0 5 6



FIGS. 1753*.

1753 **Flasks of Hard German Glass,** capable of resisting extreme and sudden changes of temperature; flat or round bottoms (figs. 1753 and 1753*):—

Contents .	2 oz.	4oz.	6oz.	8oz.	12oz.	16oz.	24oz.	40oz.
Price .	4d.	5d.	6d.	8d.	10d.	1s. 3d.	1s. 6d.	2s.

1754 **Filter and Funnel Rings** of Porcelain (fig. 1754) 4d. and 6d.

FIG. 1755. FIG. 1760. FIG. 1759.

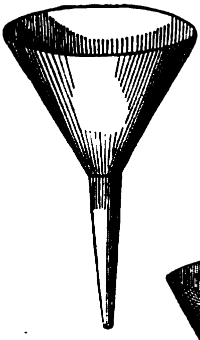
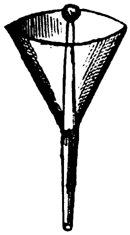
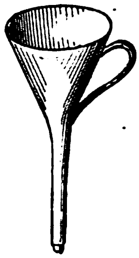
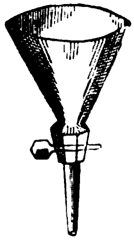





FIG. 1761.

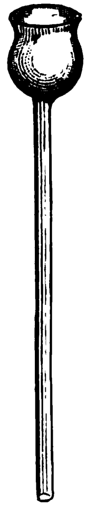
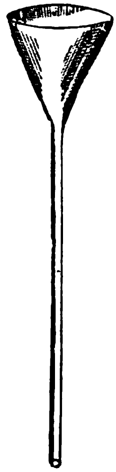
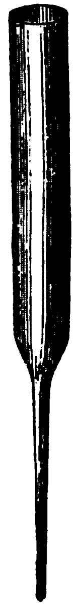
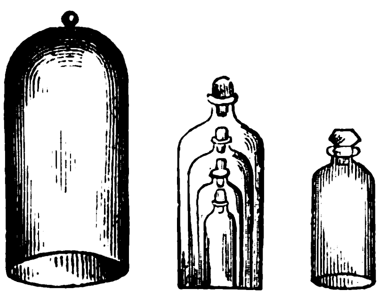
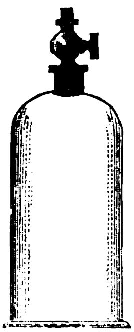
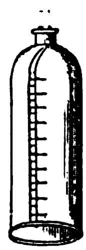
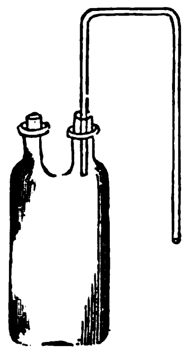





FIG. 1759. FIG. 1757. FIG. 1758. FIG. 1758*.

1755 **Funnels,** of Glass (fig. 1755):—

Diameter .	1¼ in.	1½ in.	2 in.	2½ in.	3 in.	4 in.	5 in.	6 in.
Price .	3d.	4d.	5d.	6d.	8d.	1s.	1s. 6d.	2s.

1756 **Funnels,** Wedgwood ware, best quality, from 2-oz. to 2-qts. from £0 0 9

FIGS. 1766 and 1766*. FIG. 1767. FIG. 1768. FIG. 1763.

1757 **Funnels,** long tube, thistle-headed for gas bottles, &c. of blown glass (fig. 1757):—

Length .	4 in.	13 in.	18 in.	20 in.	24 in.
Price .	4d.	6d.	9d.	1s.	1s. 3d.

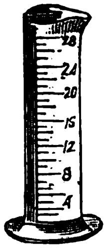
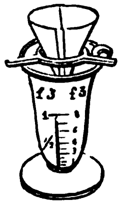
1758 **Funnels,** for filling plain Retorts without soiling the neck (figs. 1758 and 1758°) £0 2 6

1759 **Funnels,** with Handle, for introducing substances into tubes without soiling the sides (fig. 1759) £0 2 6 0 3 6

1760 Ditto with Stopper (fig. 1760) 0 4 6

1761 Ditto with Stop-Cock (fig. 1761) 0 12 6

FIG. 1859.

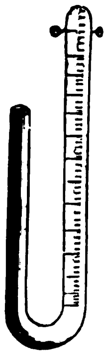
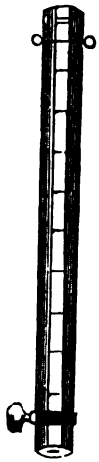
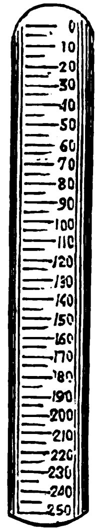





FIG. 1789*. FIG. 1754. FIG. 1799. FIG. 1745. FIG. 1746. FIG. 1745*. FIG. 1771.

		Each. £ s. d.	Each. £ s. d.
1762	**Gas Bottle, Clark's,** for preparing Sulphuretted Hydrogen,		0 2 6
1763	**Gas Bottle,** with bent glass tube, for generating Hydrogen, Sulphuretted Hydrogen, Carbonic Acid, or Chlorine Gases (fig. 1763) . . . complete		

	10 oz.	16 oz.	20oz.	40 oz.
Price . .	1s. 6d.	2s.	2s. 6d.	3s.

		Each. £ s. d.	Each. £ s. d.
1764	**Gas Flasks** with Bent tubes as (fig. 1763)		0 2 6
1765	**Oxygen Gas Retort,** of hard glass, with bent tube, for making pure Oxygen from chlorate of potash and oxide manganese		0 1 6
1766	**Gas Receivers or Deflagrating Jars** (figs. 1766 and 1766*) for containing and preserving Gases for experiment:		

Height.	Width.	Price Plain.	Price Stoppered.
5 in. . .	3 in. . .	1s . .	1s. 6d.
7 in. . .	4 in. . .	1s. 9d. .	3s.
9½ in. . .	5¼ in. . .	2s. 6d. . .	5s.
11½ in. .	6¼ in. . .	4s. 6d. . .	7s. 6d.

		Each. £ s. d.	Each. £ s. d.
1767	**Gas Receivers** mounted with brass cap, stop-cock, and bladder ferrule, (fig. 1767)		
	about 7 in. high . . . . 4 in. wide . .		0 10 6
	„ 9 in. „ . . . . 5 in. „ . .		0 12 6
1768	**Gas Receiver** (fig. 1768), mounted with Brass Cap and Stop-cock, and **Graduated** into Cubic Inches . .		0 16 6
1769	**Globular Receiver,** with welted mouth, for showing the combustion of Phosphorus, &c., in Oxygen Gas .		0 6 6
1770	**Gas Jars, Cylindrical,** Stout Glass, for exhibiting the explosive nature of a mixture of Oxygen and Hydrogen, 6d.	0 0 9	0 1 0

Fig. 1869*.

Fig. 1869.

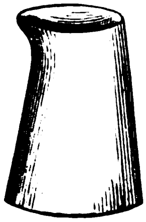


Fig. 1800.

Fig. 1798.

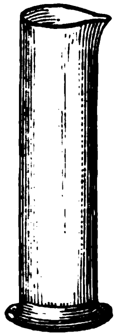


Fig. 1798.

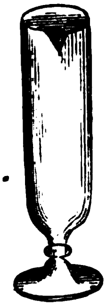


Fig. 1869*.

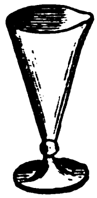


Fig. 1869.

Fig. 1791.

		Each. £ s. d.	Each. £ s. d.
1771	**Graduated Gas Tubes,** for measuring Gases, &c. (fig. 1771):—		
	4 in. ⅜ in. about 1 cubic inch, showing 1-100ths cubic inch		0 4 6
	6 in. ½ in. „ 1 „ „ 1-100ths „		0 4 6
	7 in. ¾ in. „ 3 cubic inches „ 1-50ths „		0 5 6
	10 in. 1 in. „ 1 „ „ 1-10ths „		0 6 0
	12½ in. 1¼ in. „ 14 „ „ 1-10ths „		0 9 0
1772	**Dumas's Gas Tubes,** for Nitrogen determinations, 17 in. by 1¼ in., containing about 20 cubic inches, and divided to either 1-10th of a cubic inch or cubic centimetres		0 12 6
1773	**Liebig's Gas Absorber,** for saturating a liquid with Gas, and useful in preparing a solution of any gas		0 1 6
1733°	**Kerr's Gas Tube,** stoppered and graduated to 2 cubic inches, so as to show 1-10th of a cubic inch (fig. 1773°)		0 6 0
1774	**Glass Plates,** ground, for covering Air Jars:—		

Square	2 in.	2½ in.	3 in.	4 in	8 in.
Price	8d.	10d.	1s.	1s. 6d.	2s.

		Each. £ s. d.
1775	**German Glass Tubing,** free from lead, in lengths of about 36 or 18 inches, for convenience of packing:—	
	¼ in. bore and under . . . . per lb.	0 2 6
	¾ in. ½ in. „ down to ¼ in. . . . „	0 2 0

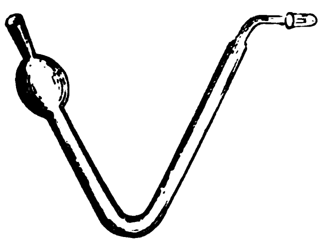


Fig. 1773*.

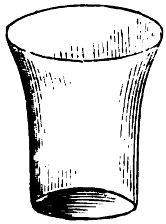


Fig. 1784.

Fig. 1784*.

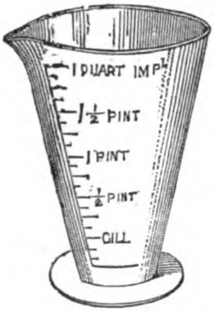


FIG. 1788.

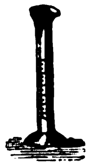


FIG. 1790.

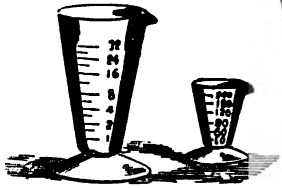


FIG. 1786.

FIG. 1787.

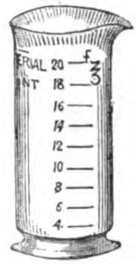


FIG. 1786*.

		Each. £	s.	d.	Each. £	s.	d.
1776	**Flint Glass Tubing,** very soft, easily bent and worked:—						
	¼ in. bore and under . . . . per lb.				0	2	6
	1 in. ⅛ in. ,, down to ¼ in. . . . . ,,				0	1	6
1777	**Combustion Tube,** German Glass . . . . . ,,				0	3	0
1778	**Gauge Tube,** for Steam Boilers, &c., according to diameter, see page 173 . . . . . . per inch	0	0	1	0	0	2
1779	**Glass Rod,** of various diameters . . . per lb.	0	2	0	0	2	6
1780	**Glass Inhalers**				0	10	6
1781	**Lamp, Hydrogen,** Dobereiner's	0	15	0	1	10	0
1782	**Lamps, Spirit,** glass, round tops and brass mounts, (figs. 1849 and 1849*) . . . . . . 2s., 3s.	0	4	0	0	6	6
1783	Ditto ditto, Common Mountings	0	1	6	0	2	6

1784 **Lixiviating Jars** (figs. 1784 and 1784*) of German Glass, strong and convenient in shape, for cold fluids:—

Contents . .	1 pt.	1½ pt.	2 pts.	3 pts.
Price . .	1s.	1s. 4d.	2s.	2s. 9d.

		Each. £	s.	d.	Each. £	s.	d.
1785	**Liebig's Retort,** with extra neck for passing gases over any substance while heated for distillation, best hard Bohmenian glass (fig. 1785)	0	5	6	0	7	6

1786 **Measures,** Graduated Glass, showing ounces and drachms (figs. 1786 and 1786*):—

Conical or Cylindrical Form	1-oz.	2-oz.	4-oz.	8-oz.	10-oz.	20-oz.	40-oz.
Price . .	1s.	1s. 2d.	1s. 9d.	2s.	2s. 6d.	3s 6d.	5s.

1787 **Measures,** Glass, Graduated Imperial Pint (fig. 1787)
1788 Ditto ditto ditto Quart (fig. 1788)
1789 Measures divided to show equal parts, grains, cubic inches, or centimetres &c., to order (fig. 1727)

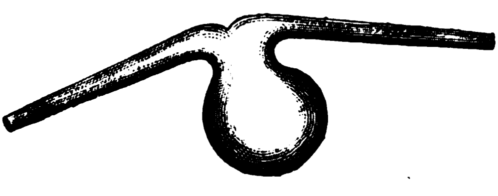


FIG. 1785.

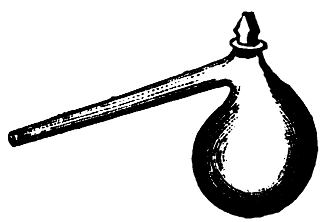


FIG. 1802.

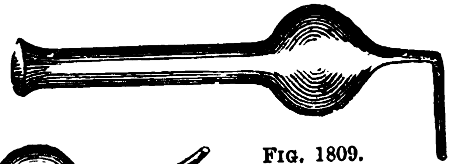


FIG. 1809.

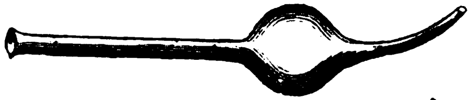


FIG. 1809*.

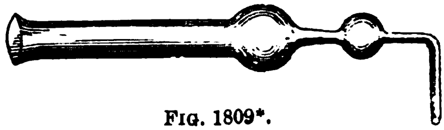


FIG. 1809*.

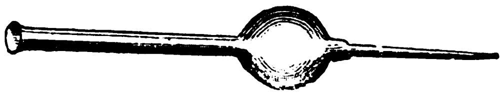


FIG. 1803.

FIG. 1803*.

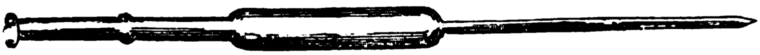


FIG. 1805.

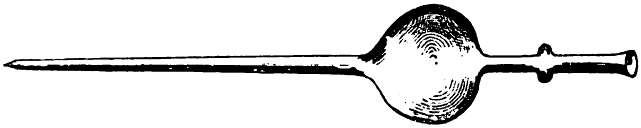


FIG. 1805*.

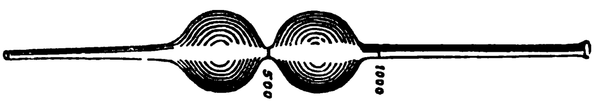


FIG. 1807.

No.	Article		Each. £ s. d.	Each. £ s. d.
1790	**Measures,** Glass, one drachm, divided into drop or 60 minims (fig. 1790)			0 1 2
1791	Ditto, Cubic Inch divided into 10ths (fig. 1791) . .			0 5 6
1792	**Mercurial Trough,** Porcelain (fig. 1792) .	from	0 2 6	0 5 6
1793	**Mortars and Pestles,** Agate.			

The prices are only approximate, as they vary according to the soundness of the materials, as well as size :—

Diameter	1¼-in.	1½-in.	2-in.	2¼-in.	2½-in.	3-in.	4-in.	6-in.
Price	8s. 6d.	9s.	10s.	12s.	15s.	20s.	55s.	60s.

No.	Article		Each. £ s. d.	Each. £ s. d.
1794	**Mortars and Pestles,** Berlin porcelain .	1s. 6d., 2s 6d.,	0 3 6	0 5 6
1795	**Mortars and Pestles,** best quality, Wedgwood ware :—			

Diameter	2¼-in.	2½-in.	3-in.	3¼-in.	3½-in.	4½-in.	6½-in.
Price	1s.	1s. 4d.	1s. 6d.	2s.	2s.	2s. 6d.	5s.

No.	Article		Each. £ s. d.	Each. £ s. d.
1796	**Ditto, in Stout Glass** .	2s. 6d. 3s. 0d. 3s. 6d.	0 4 6	0 6 6

FIG. 1806.

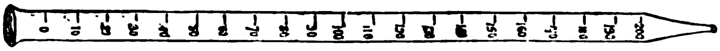


FIG. 1806*.

		Each. £	s.	d.	Each. £	s.	d.
1797	**Muffles** . . . . 9d. 1s.	0	1	6	0	2	6
1798	**Mixing Jars** for Alcalimetry (figs. 1798 and 1798*) .	0	1	0	0	2	6
1799	**Test Mixers** (fig. 1799), for preparing Test Acid; containing 1,000 septems, divided into 100 divisions .				0	9	0
1800	**Parting Glasses**, for assaying (fig. 1800) . from				0	0	9
1801	**Pneumatic Trough**, mercurial, Berlin ware, for tube experiments (fig. 1792)				0	4	0
1802	**Porcelain Retort, (Berlin)** tubulated and stoppered, contents about forty fluid ounces (fig. 1802) . .				0	13	6
1803	**Pipettes**, with Round or Pear shaped bulbs (figs. 1803 and 1803*)	0	0	6	0	0	8
1804	**Pipettes**, or Dropping Tubes, straight bulb, 6-in. long	0	0	6	0	0	8
1805	Ditto, with elongated bulb, for use in Edulcoration (fig. 1805 and 1805*)				0	1	0
1806	**Pipettes, Graduated**, for delivering exactly 1,000, 700, 500, 350, or 50 Grains, Cubic Centimetres, Equal Parts, or any quantity to order (figs. 1806 and 1806*), 3s. 6d., 5s. 6d.	0	7	6	0	10	6
1807	**Pipettes**, with two bulbs, for delivering exactly 500 and 1,000 grains (fig. 1807)				0	5	0

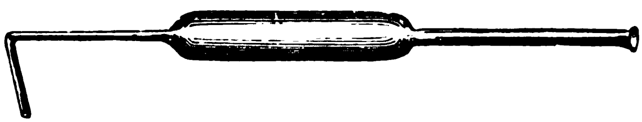


FIG. 1808.

1808	**Pipettes**, for passing a Solution of Potash into a Gas contained in a Tube over mercury (fig. 1808 and 1808*)				0	1	4

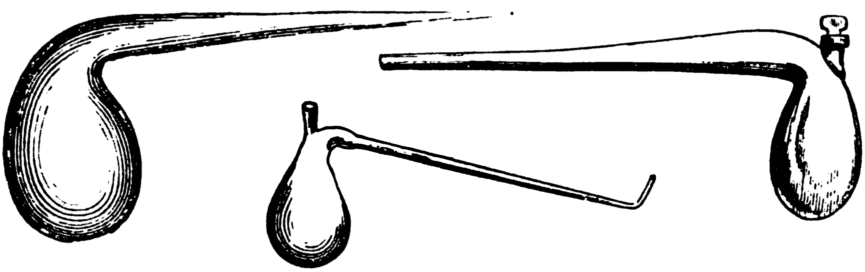


FIG. 1822. FIG. 1826. FIG. 1822*.

RETORTS, Glass, various forms and sizes, see also next page.

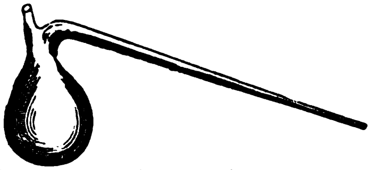


FIG. 1825*.

FIG. 1825.

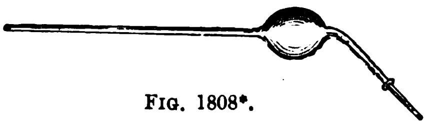


FIG. 1808*.

FIG. 1810.

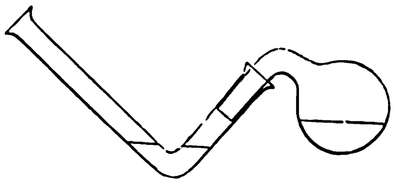


FIG. 1827.

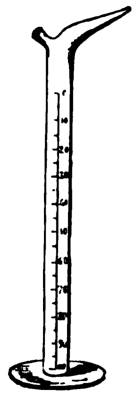


FIG. 1811.

		Each. £ s. d.	Each. £ s. d.
1809	**Pipettes**, with bent points (figs. 1809 and 1809*) . .	0 0 8	0 1 0
1810	**Percolator Glass**, for preparing tinctures, &c.(fig. 1810)		1 15 0
1811	**Pourettes or Burettes**, divided into Grains, Grammes, Equal Parts or Cubic measures (fig. 1811) . . .	0 5 6	0 7 6
1812	**Precipitating Glasses**, on foot (fig. 1812) 8-oz. 1/6, 10-oz. 2/		
1813	Ditto ditto Philip's /7 /8 /9		0 1 0
1814	**Pulse Tubes**		0 1 6
1815	**Reduction Tubes**, 12-in. tube, 1 or 2 bulbs, straight or bent	0 1 0	0 1 6
1816	**Reduction Tubes**, with one bulb, the tube bent, for decomposing oxide of copper by heat, in hydrogen gas		0 1 6
1817	**Retorts**, Earthenware, plain	0 1 6	0 2 6
1818	**Retorts**, Earthenware, to open in the middle . .	0 3 0	0 4 0
1819	Ditto, of hard glazed Stoneware, for Acids . from		0 7 6
1820	Ditto, of Berlin Porcelain, for high temperatures, plain	0 4 6	0 7 6
1821	**Retort**, Porcelain, Stoppered		0 10 6
1822	**Retorts** of hard German glass (figs. 1822 and 1822*) :—		

	Contents	2-oz.	4-oz.	6-oz.	8-oz.	12-oz.	1-lb.	1½-lb.	2-lb.	3-lb.
	Plain .	4d.	4d.	6d.	8d.	9d.	10d.	1s.	1s. 6d.	2s.
1823	Tubulated	7d.	8d.	10d.	1s.	1s. 2d.	1s. 3d.	1s. 6d.	2s.	2s. 6d.
1824	Stoppered		1s.	1s. 4d.	1s. 6d.	2s.	2s. 3d.	2s. 6d.	3s.	3s. 6d.

1825	**Retorts** (Small) of blown Glass, 2 to 4-oz. capacity, plain and stoppered (fig. 1825 and 1825*)	0 0 9	0 1 3
1826	**Ditto** ditto, with bent point (fig. 1826) . . .		0 1 6

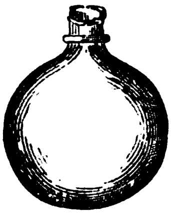
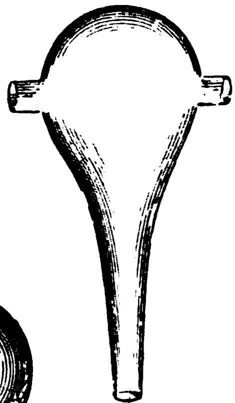


FIG. 1829.



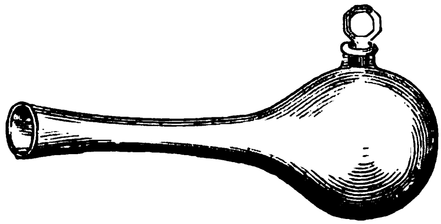


FIG. 1832.

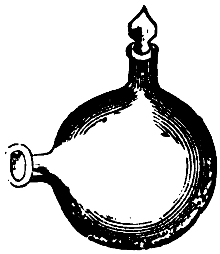


FIG. 1831. FIG. 1834. FIG. 1830.

		Each. £ s. d.	Each. £ s. d.
1827	**Retort and Receiver,** Clark's (fig. 1827), exceedingly useful in small distillation		0 1 6
1828	**Receivers,** of blown glass, 1-oz. to 2-oz. capacity, plain and tubulated	0 0 9	0 1 0

1829 **Receivers,** Plain, bolt heads, short neck (fig. 1829):—

Contents .	4-oz.	8-oz.	12-or.	
Price . .	6d.	8d.	9d.	
Contents .	1-lb.	1½-lb.	2-lb.	3-lb.
Price . .	1s.	1s. 2d.	1s. 6d.	2s.

1830 **Receivers,** with long neck (fig. 1830):—

Contents .	1-lb.	1½lb.	2-lb.	3-lb.
Price . .	1s.	1s. 2d.	1s. 6d.	2s.

1831 Ditto, with Tubulure Stoppered, the neck short (fig. 1831):—

Contents .	4-oz.	8-oz.	1-lb.	2-lb.
Price . .	8d.	10d.	1s. 2d.	1s. 10d.

1832 **Receivers,** with Tubulure Stoppered, the neck long (fig. 1832):—

Contents .	4-oz.	8-oz.	1 lb.	2-lb.
Price . .	1s. 2d.	1s. 4d.	1s. 10d.	2s. 6d.

FIG. 1833.

		Each. £ s. d.	Each. £ s. d.
1833	**Receivers** for preparing Nitric Acid (fig. 1833) . .		0 4 6
1834	**Receivers** with three necks (fig. 1834)	0 5 6	0 8 6

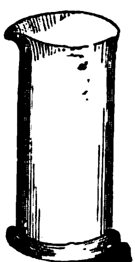


FIG. 1812.

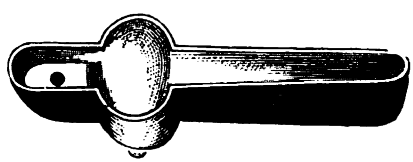
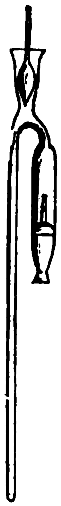
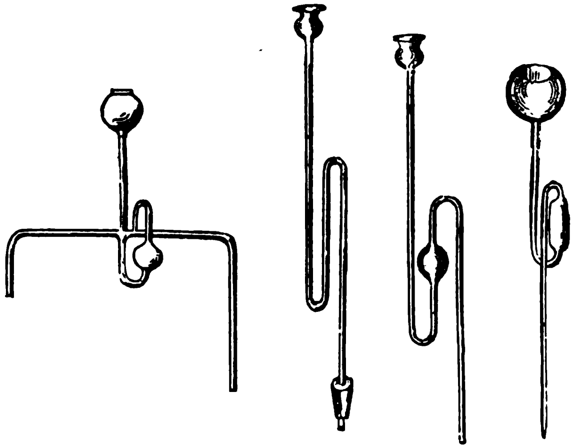


FIG. 1792.





FIGS. 1839.

FIG. 1841. FIG. 1838. FIG. 1840.

		Each. £	s.	d.	Each. £	s.	d.
1835	**Receivers**, V shaped, small size, of German glass (fig. 1835)	0	1	0	0	1	3
	Ditto, U shaped, large size, of German glass . . .	0	1	6	0	2	6
1836	**Receivers**, with delivery tube (fig. 1836), for distilling small portions of substances that require the receiver to be surrounded by ice				0	3	6
1837	Ditto ditto fitted to a japanned copper vessel .				0	10	6
1838	**Funnel**, with bent tube for charging retorts (fig. 1838)				0	1	0
1839	**Safety Funnels** (Welter's), for gas bottles, retorts, &c., various forms (figs. 1839)	0	1	6	0	2	6
1840	Ditto, with four bulbs, preventing any fluid in the funnel reaching the retort by sudden condensation (fig. 1840)				0	3	6
1841	**Safety Funnel**, with two valves which obviate the necessity of using mercury or fluid in the funnel (fig. 1841)				0	5	6

FIG. 1843.

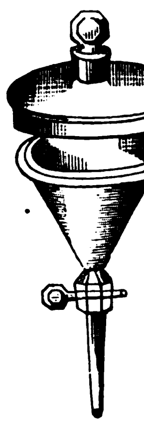


FIG. 1842.

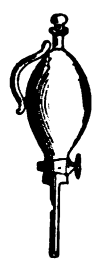


FIG. 1844.

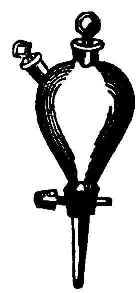


FIG. 1844*.

No.		Each. £ s. d.	Each. £ s. d.
1842	**Separating Funnel,** with Stop-Cock and Glass Cover (fig. 1842)		0 16 0
1843	**Separating or Florentine Receivers** (fig. 1843) . .		0 4 6
1844	Ditto (figs. 1844 and 1844*), with Stop-Cock and Stopper		0 18 6
1845	**Specific Gravity Bottles,** of 1000 grains capacity, with adjustable counterpoise, in japanned tin case . .		0 10 6
1846	Ditto, of 500 grains		0 8 6
1847	Ditto, of 250 grains		0 7 6
1848	Ditto, 1 cubic inch		0 7 6

FIG. 1835.

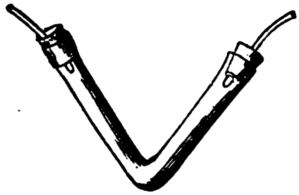
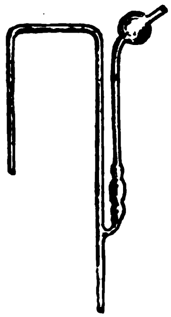


FIG. 1861.



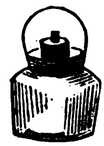
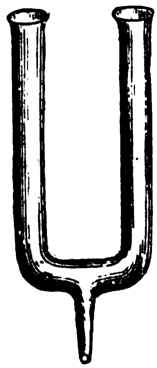
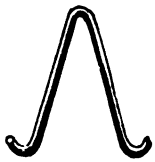


FIG. 1849.





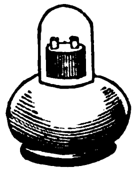


FIG. 1862. FIG. 1849*. FIG. 1836.

FIG. 1903.

1849 **Spirit Lamps** of Glass, with ground caps and Brass wick-holders (figs. 1849 and 1849*):—

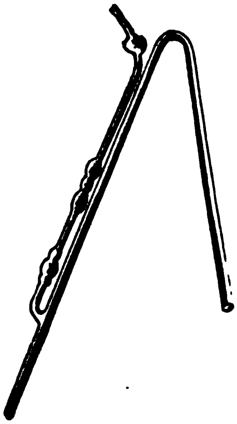
Contents .	2-oz.	4-oz.	8-oz.
Price . .	2s.	3s.	5s.

If with screw wick holders, 6d. each extra.

No.		Each. £ s. d.	Each. £ s. d.
1850	**Spoons,** stout glass for transferring small quantities of acid, &c., from one vessel to another	0 2 6	0 5 6
1851	**Stirrers,** of soft glass, that do not scratch glass vessels in which they are used :—		

Length .	4-in.	6-in.	9-in.	12-in.
Price (per doz.) .	1s.	1s. 3d.	2s. 6d.	3s.

No.		Each. £ s. d.	Each. £ s. d.
1852	**Stirrers,** unprepared, in lengths of 18 or 24-in. per lb. .		0 1 6
1853	**Stone Ware Still and Worm,** hard glazed, from 1 gall.		1 15 6
1854	**Stone Ware Adapters and Taps,** Acid Jugs, Ladles, Funnels, Bottles, Pots, Evaporating Dishes, and Coolers, &c., of various sizes and shapes		
1855	**Stop-Cocks,** solid Glass, accurately fitted, the open end straight and adapted to receive a tube fitted with cork		0 6 0
1856	Ditto, with Bent End, for running off a liquid . .		0 7 6
1857	**Sulphuric Acid Dish,** for desiccating purposes . .		0 4 6
1858	**Sulphuretted Hydrogen Gas Bottle** (fig. 1858) . .		0 3 0
1859	**Suction Tube** (fig. 1859), for filling Potash Apparatus and to ascertain if the connections are Air Tight .		0 0 9
1860	**Syphon** of a simple form		0 1 0
1861	Ditto, with Suction Tube (fig. 1861 and 1861*) . . .	0 2 6	0 3 0



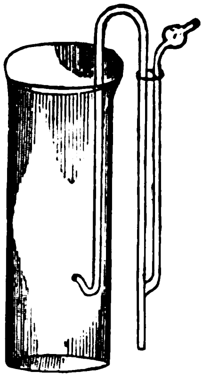
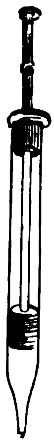
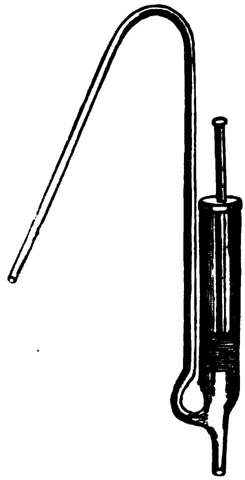




FIG. 1861*. FIG. 1882. FIG. 1863. FIG. 1866. FIG. 1865.

1862 **Syphon, Wurtemberg** (fig. 1862) . . 2s. 6d., 5s.
1863 **Syphon, Mitscherlich's,** suction tube with bulb, and the end bent upwards (fig. 1863) . . . 3s. 6d.
1864 Ditto, with Stopcock . . . . . . 10s. 6d.
1865 **Syphon,** with Negretti and Zambra's adaptation of syringe, useful where Acids, &c., are being drawn off (fig. 1865) . . . 5s. 6d.

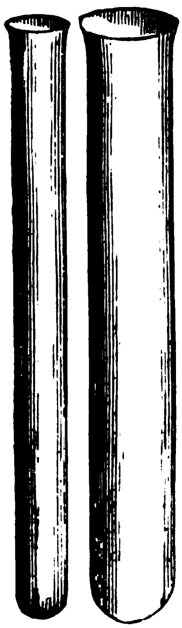
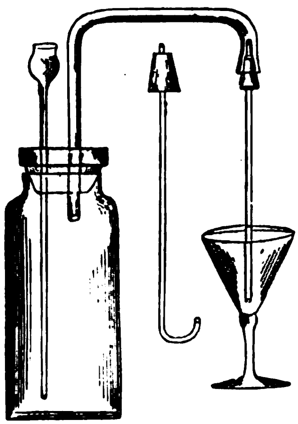




FIG. 1866*.

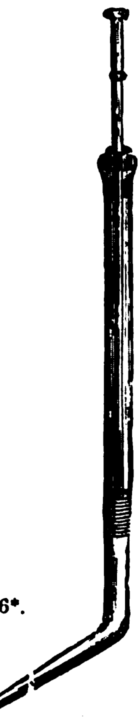


FIG. 1872. FIG. 1858. FIG. 1866. FIG. 1868. FIG. 1867.

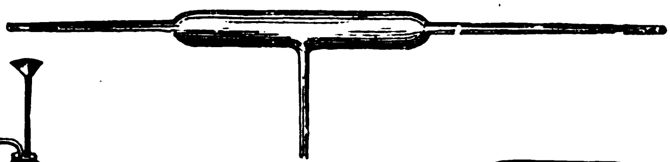


FIG. 1878.

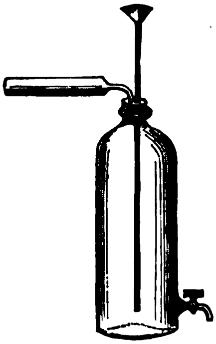


FIG. 1885*.

FIG. 1885.

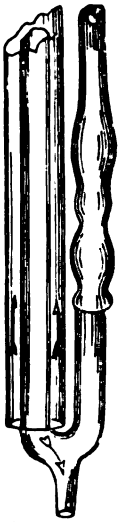


FIG. 1890.

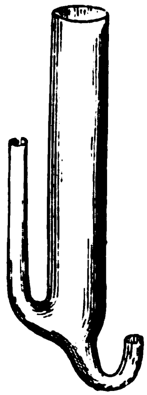


FIG. 1887.

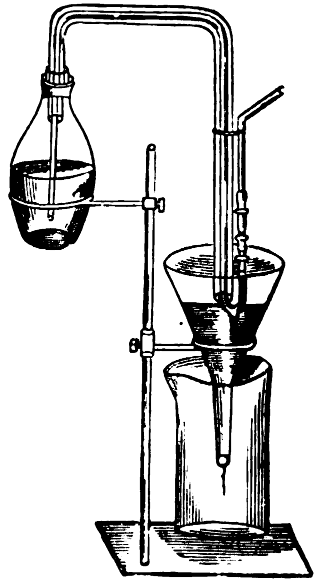


FIG. 1891.

		Each.			Each.		
		£	s.	d.	£	s.	d.
1866	**Syringes** of Glass (figs. 1866 and 1866*)	0	1	0	0	1	6
1867	Ditto, with bent point (fig. 1867)				0	2	0
1868	**Thermometers,** various, for chemical purposes (fig. 1868, see also page 137) insulated in glass tube	0	5	6	0	7	6
1869	**Test Glasses,** Conical, Clark's pattern (fig. 1869	0	0	8	0	0	9
1869*	**Test Glasses,** Cylindrical, for lecture table (figs. 1869* and 1869**) :—						

Capacity	12-oz.	8-oz.	4-oz.
	1s. 6d.	1s. 4d.	9d.

1870 Ditto ditto Conical form :—

Contents	2-oz.	4-oz.	6-oz.	8-oz.
Price	8d.	10d.	1s.	1s. 4d.

		£	s.	d.
1871	**Test Mixer,** Graduated and Stoppered for quantative analysis (fig. 1871)	0	8	6

1872 **Test Tubes** (fig. 1872), of German glass, free from lead, carefully rounded at the closed end, and bordered at the mouth :—

Diameter.	Length.	Per Dozen.		
¼-in.	2 and 2½-in	0	1	0
½-in.	3, 3½, 4, 4½, 5, and 6-in	0	1	6
⅝-in.	4½, 5, 5½, and 6-in.	0	2	0
¾-in.	4, 5, and 6-in.	0	2	6
1-in.	5 and 6-in.	0	3	0
1-in.	7 and 9-in.	0	4	6

1873	**Tube Flasks**	per doz.	0	4	0	0	6	0
1874	**Tube Retorts**	each	0	0	6	0	0	8

FIG. 1893.

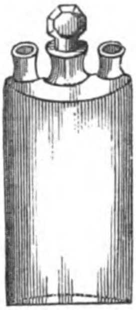


FIG. 1894.

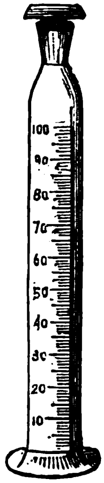


FIG. 1871.

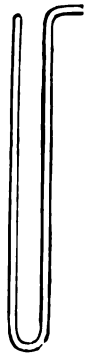


FIG. 1879.

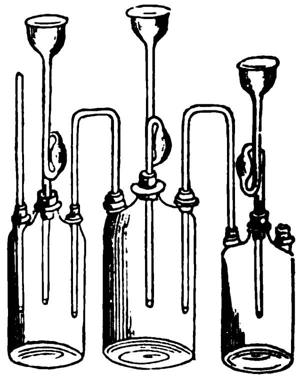


FIG. 1896.

1875 **Tubes** of Berlin Porcelain, for containing substances to be heated to redness :—

Length .	18-in.	24-in.	18-in.	24-in.	18-in.	24-in.
Diameter	¼-in.	½-in.	¾-in.	¾-in.	1-in.	1-in.
Price .	4s. 6d.	5s. 6d.	7s. 6d.	7s. 6d.	10s. 6d.	12s.

1876	**Trays**, flat, Porcelain, for washing papers, &c. 1s. 6d.	£0	2	6		£0	4	6
1877	Ditto, shallow, Glass . . . . . : from					0	3	6
1878	**Tubes**, three-limb and letter Z, for adjusting apparatus to the exhausting syringe (fig. 1878)	0	1	6		0	1	9
1879	**Tubes**, long Glass conducting, U shape (fig. 1879) .					0	1	6
1880	**Turpentine Bulbs**, of glass, for containing volatile substances about to be analysed . . . per doz.					0	1	0
1881	**Watch Glasses** . . . . per doz.	0	2	0		0	4	0
1882	**Water Hammers** (fig. 1882)					0	4	6
1882*	Ditto ditto, best make	0	8	6		0	12	0
1883	**Water Baths**, for drying precipitates or explosive compounds, stone ware or porcelain					0	3	6
1884	**Water or Oil Bath**, of Berlin Porcelain, especially adapted for drying a precipitate contained on a filter					0	4	6

1885 **Water Bottle**, stoppered, with glass tap, for holding distilled water, &c.; also useful as Aspirators (figs. 1885 and 1885*) :—

Contents	4-lb.	6-lb.	8-lb.	12-lb.	20-lb.	24-lb.
Price .	11s. 6d.	12s. 6d.	15s.	18s.	25s.	30s.

1886	**Washing Bottle, Berzelius' Fountain**, for washing precipitates by a continual jet of water	0	2	6
1887	The Tube only (fig. 1887)	0	1	6
1888	**Washing Bottles, Gmelin's**, fitted to a 16-oz. flask .	0	2	6
1889	**Washing Bottle, Syphon**, improved form, in which a current of water is supplied continuously . . .	0	6	0
1890	The Tube only (fig. 1890)	0	4	9
1891	**Washing Bottle**, improved form, complete with support, funnel and receiving jar (as fig. 1891) . .	0	16	0

No.	Article	Each. £ s. d.	Each. £ s. d.
1892	**Volumeter,** 1,000 grains capacity, divided into 100 equal parts (fig. 1871)	0 5 6	0 7 6
1893	**Woulffe's Bottles,** well made plain necks, so as to cork easily; with two necks shape as fig. 1893:—		

Contents	½-lb.	1-lb.	2-lb.	4-lb.	6-lb.	8-lb.	10-lb.
Price	1s.	1s. 6d.	2s. 6d.	3s. 8d.	5s.	7s. 6d.	8s. 6d.

1894 **Woulffe's Bottles,** with three plain necks, shape as fig. 1894:—

Contents	½-lb.	1-lb.	2-lb.	4-lb.	6-lb.	8-lb.	10-lb.
Price	2s.	2s. 6d.	3s. 4d.	4s. 8d.	6s.	9s. 6d.	11s. 6d.

1895 **Woulffe's Bottles,** with one neck, accurately Stoppered, as (figs. 1893 and 1894):—

	1-pint.	2-pints.	3-pints.
2-neck	3s. 2d.	3s. 8d.	4s. 6d.
3-neck	3s. 8d.	4s. 6d.	5s. 6d.

No.	Article	Each. £ s. d.	Each. £ s. d.
1896	**Woulffe's Bottles,** a set of three 1-pint, in a Mahogany tray, fitted with safety funnels, tubes and connectors (fig. 1896)		0 18 6

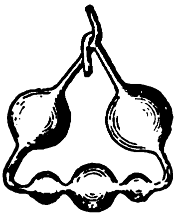


FIG. 1905.

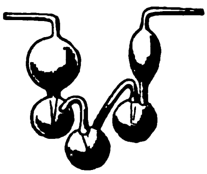


FIG. 1905*.

FIG. 1913.

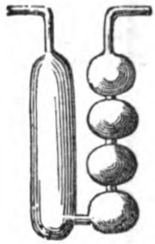


FIG. 1906.

APPARATUS FOR ORGANIC ANALYSIS, &c.

No.	Article	Each. £ s. d.	Each. £ s. d.
1897	**Apparatus** for illustrating the Composition of Water Synthetically, by burning Hydrogen gas in atmospheric air		0 5 0
1898	**Berzelius' Sulphretted Hydrogen Apparatus** (figs. 1898)		0 8 6
1898*	Ditto, ditto, with extra Washing Bottle (fig. 1898*) .		1 12 6
1899	**Cavendish's Apparatus** for detonating a mixture of Oxygen and Hydrogen Gas, illustrating the Composition of Water		2 12 6
1900	**Donovan's Apparatus** for Filtering Caustic Potash (fig. 1900)		1 10 0
1901	**Dobereiner's Extracting Apparatus** (fig. 1810) . .		1 15 0
1902	**Fritzch's Apparatus,** for Analysis of Carbonates		0 2 0
1903	**Glass Apparatus** for showing Diminished Bulk by mixing Sulphuric Acid and Water (fig. 1903) . .		0 5 0
1904	**Glass Apparatus,** for exhibiting the Philosophical Candle and producing musical sounds by Hydrogen Gas . . . . from		0 10 6
1905	**Leibig's Potash Apparatus,** made very light from German glass, free from lead (figs. 1905 and 1905*) .	0 2 6	0 3 6

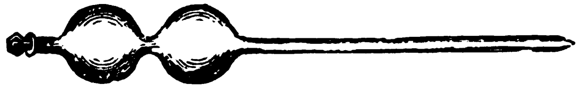


FIG. 1903.

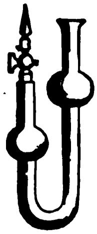


FIG. 1907.

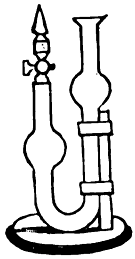


FIG. 1908.

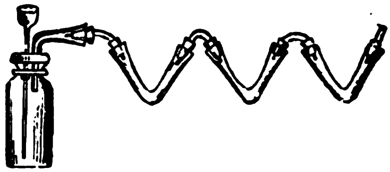


FIG. 1909.

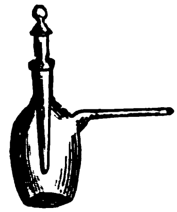


FIG. 1898.

		Each. £ s. d.	Each. £ s. d.
1906	**Mitscherlich's Potash Apparatus,** very light (fig. 1906)		0 3 0
1907	**Marsh's Apparatus** for detecting Arsenic (fig. 1907) .		0 7 6
1908	Ditto, ditto, on Stand (fig. 1908)		0 9 6
1909	**Clark's Apparatus** for detecting Arsenic (fig. 1909) .		0 10 6
1910	**Percy's Apparatus,** for analysis of Carbonates . .		0 7 0
1911	**Ure's Apparatus** for determining the quantity of Nitrogen (fig. 1911)	0 4 0	0 6 6

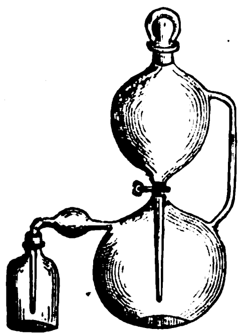


FIG. 1900.

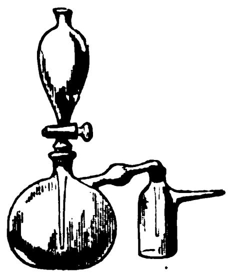


FIG. 1898*.

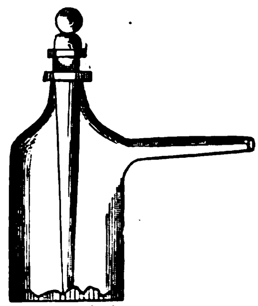


FIG. 1898.

1912	**Will and Varrentrap's Nitrogen Bulbs**		0 1 6
1913	**Nitrogen Bulb with Horsford's Modification** (fig. 1913)		0 3 0
1914	**Bell-shaped Dialyser of Glass,** with two Flanges . .		0 1 6
1915	**Cylindrical Glass Jars,** for using above	0 3 6	0 5 6
1916	**Parchment Paper,** for use with Dialyser, best quality 8½ by 6 inch, 1s. 6d.; 10½ by 6 inch, 2s.; 12 by 12 inch, 2s. 6d.; 14 by 12 inch, 3s. 6d. per dozen.		
1917	**Flat Conical Glass Basins,** with Spout for holding Distilled Water below the Dialyser, and collect the Diffusate . . . . 3s. 6d.	0 5 6	0 6 6
1918	**Dialysers, Tube Form, Dr. Alfred S. Taylor's Form,** for testing Mineral Poisons		0 5 6

Sets of Chemical Apparatus and Tests adapted for the Analysis of Soils, Manures, &c., &c., or for the examination of Adulterated Articles of Food fitted up to order. See also end of Chemical Section, page 370.

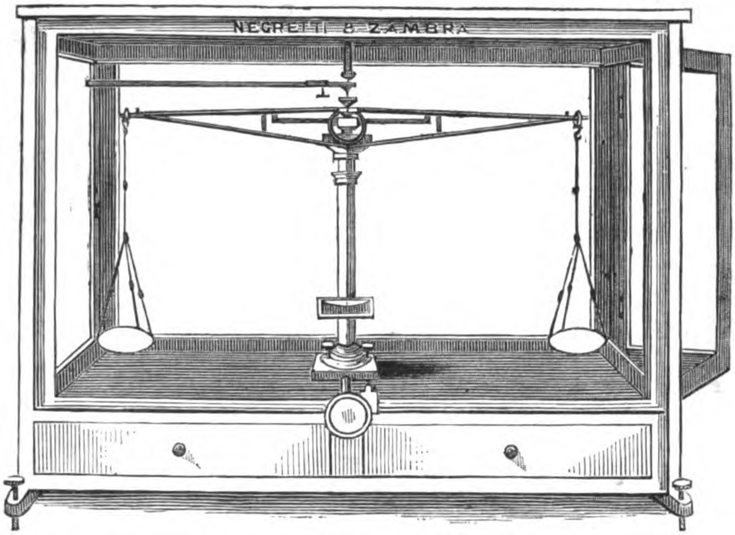


FIG. 1929.

CHEMICAL AND PHILOSOPHICAL INSTRUMENTS AND APPARATUS.

		Each.			Each.		
		£	s.	d.	£	s.	d.
1919	**Anvils, Mineralogical, Hardened Steel,** small, Square .	0	5	0	0	7	6
1920	**Argand Spirit Lamp,** of **Brass,** with circular wick .				1	10	0
1921	**Aspirators,** Bruner's, in japanned **Tin** or **Zinc** (see fig. 54*, page 49) See also Water Bottles . .				1	5	0
1922	**Balances or Grain Scales,** Brass Pans, and set of weights from 120 grains to ½-grain, in Oak box . .	0	3	0	0	3	6
1923	Ditto, superior make, in Mahogany box (fig. 1923) .				0	4	6
1924	Ditto, with Glass Pans, in Oak box				0	6	6
1925	Ditto, with Glass Pans and box-end beams, in Mahogany box	0	10	6	0	18	0
1926	**Grain Scales,** with Pillar, on Mahogany stand (fig. 1926)				1	10	0
1927	**Balances, Chemical,** with a set of Decimal Weights to the tenth of a grain, to carry 1000 grs. in each pan, and turn with the tenth of a grain when thus loaded; in Mahogany box (fig. 1927)	3	3	0	4	4	0
1928	**Balances, Chemical,** with Glass Cases, highly finished and carefully adjusted, to turn with $\frac{1}{100}$th of a grain or one Milligramme . . . . . . £8 8s.	10	10	0	12	12	0
1929	**Balances, Assay,** with framed beam and steel knife, edges resting on Agate planes, sliding weight on beam, with adjustments, in **Glass Lantern,** with levelling screws, &c., of the most delicate accuracy, to turn with $\frac{1}{1000}$th of a grain (fig. 1929)	15	15	0	25	0	0

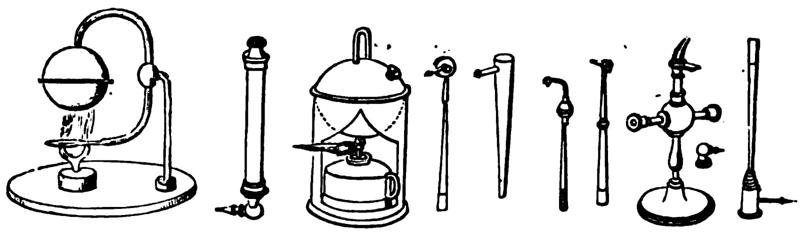


FIG. 1943. FIGS. 1941. 1943*. 1940. 1938. 1939. 1940. 1942. 1941.

1930 **Balloons**, for inflation with Hydrogen or Coal Gas :—

Diameter	9-in.	10-in.	12-in.	16-in.	18-in.	20-in.	36-in.
Price	1s. 6d.	2s. 6d.	3s. 6d.	4s. 6d.	5s. 6d.	8s. 6d.	36s.

		Each. £	s.	d.	Each. £	s.	d.
1931	**Balloons**, oval shape, 3-ft. high and 2-ft. diameter .				1	1	0
1932	**Balloons**, fish shape, 15-in. and 30-in. long . . .				0	18	0
1933	**Bladders**, mounted with Ferrules				0	3	6
1934	Ditto ditto and Stop-Cock	0	5	6	0	7	6
1935	**Bar Compound**, for showing the unequal expansion of metals by heat	0	8	6	0	15	0
1936	**Bars of Antimony, Bismuth, Copper, Iron, Lead, Tin, and Zinc**, for precipitating metals from solution, from				0	0	4
1937	**Blowpipes**, common Brass	0	1	0	0	1	6
1938	Ditto, Black's (fig. 1938)	0	1	0	0	2	0
1939	Ditto, Bergman's improved (fig. 1939), with two jets .				0	7	6
1940	**Blowpipes**, various patterns: Berzelius (fig. 1939); **Pepy's** (fig. 1940) with moveable Jet, for use at any angle; or **Wollaston's** Portable Pocket form 1941 from	0	10	6	0	12	6
1941	**Blowpipe**, Hemming's Safety, Oxy-Hydrogen (fig. 1941)				0	10	6
1942	**Blowpipe, Oxy-Hydrogen**, complete with Lime-Holder, Stopcocks, &c. (fig. 1942)				2	10	0
1943	**Blowpipes**, Spirit, Self-acting, for bending glass tubes, strong Tin				0	7	6
1944	Ditto ditto, Copper Ball (figs. 1943 and 1943*) .				0	10	6
1945	**Blowpipe**, Self-Acting, Gas and Steam, very convenient and powerful for small solderings, brazings, or fusions	1	10	0	2	2	0
1946	**Blowpipes**, Spirit, or Russian Furnace	0	10	6	0	15	0
1947	Ditto ditto, with ring and support				0	18	6
1948	**Tilley's Water Pressure Blowpipe**, with jets, &c., complete, in japanned tin				1	10	0
1949	**Glass Blower's Table**, with best double-action bellows, jointed motion to jet-holder, and two jets (fig. 1949) .				3	3	0
1950	**Glass Blower's Lamps** (figs. 1950 and 1950*) . . .	0	3	0	0	5	0

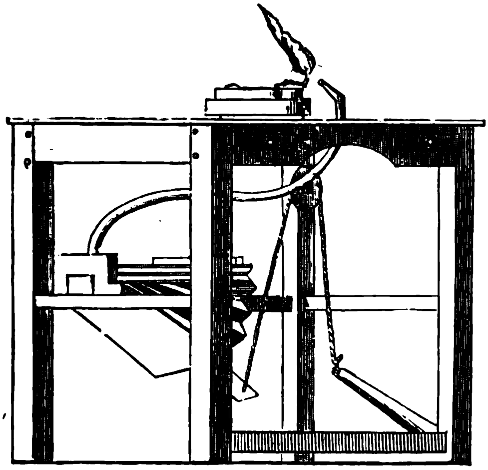


FIG. 1949.

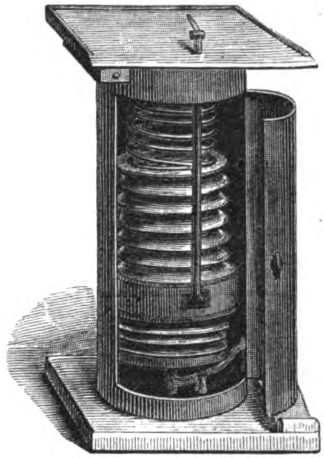


FIG. 1951.

		Each. £ s. d.	Each. £ s. d.
1951	**Glass Blower's Apparatus, Patent,** consisting of a circular column of japanned zinc, table covered with zinc (having brass-bound edges), double action circular bellows, drawer, and universal jointed jet (fig. 1951)		5 10 0
1952	Ditto ditto without Zinc cover to the table .		5 0 0

1953 **Blowpipe, Hot Blast,** Fletcher's Patent, specially designed for Jewellers, Dentists, Plumbers, &c. (fig. 1953). The jet tips screw on, and any size can be supplied, or used with the same blowpipe. Price in strong brass, with one jet, 1s. 6d., with bone mouthpiece . . price 2s. 6d.

1954 **The Ordinary Chemical Blowpipe** (fig. 1954) with the Patent Hot Blast arrangement. Price, with tin tube and brass coil, and jet to screw on, 2s. 6d. In brass, with bone or ivory mouthpiece, 5s. Extra jets brass, 6d.; with platinum tips, 1s. each.

1955 **Chemical Blowpipe and Hand Blower** (fig. 1955), with folding stand, adjustable at any height or angle. It can be used either with the mouth, or the hand blower can be attached and the blowing done by the finger. With this Blowpipe is supplied, one jet with, and one without, the Patent Coil, to enable a larger variety of flame to be obtained; and one Brass and one Platinum pointed tip. Price complete, in Tin Case with spare rubber Discs, 12s. 6d.

1956 **Hand Blower and Chemical Blowpipe,** complete in case (5¼ by 4¼ by 1¾ inches, outside measure) for the pocket . . . price 15s.

1957 **Foot Blowers,** for Blowpipe work, Autogenous Soldering or Furnace use. 21s., 30s., 35s.

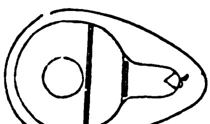


FIG. 1930.

FIG. 1950*.

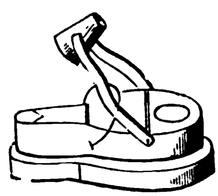


FIG. 1950†.

FIG. 1954.

FIG. 1953.

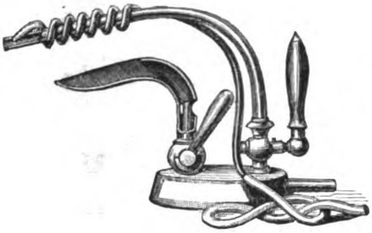


FIG. 1958. No. 1.

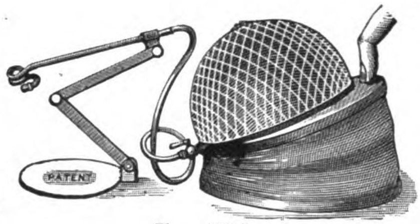


FIG. 1955.

FIG. 1958. No. 2.

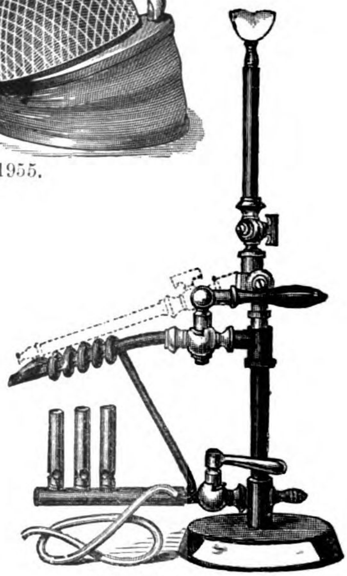


FIG. 1958. No. 3.

1958 **Hot Blast Blowpipe**, for temperatures above those obtained by the ordinary gas and air blowpipe. It will seem by the wood-cut (fig. 1958) that the tube of the **Air Jet** is coiled round the gas tube, both being heated by a Bunsen Burner underneath each, being controlled by separate taps.

The jet when reduced down to a small point of flame is nearly equal in power to the Oxy-Hydrogen Jet, readily fusing a moderately thick Platinum Wire. It is a most useful arrangement for Chemical, Soldering, and general Workshop use.

This Blowpipe is made of three sizes or patterns: (fig. 1958, No. 1.), price 12s; (fig. 1958, No. 2.), price 15s; (fig. 1958, No. 3.), improved arrangement, price 28s.; 3 sizes of jets are made to suit the nature of the work to be done: small for Chemical use, medium and large for Soldering. One Jet is supplied with each Blowpipe of medium size.

1959	**Blowpipe Jets,** Platinum	from				£0	2	6
1960	**Blowpipe Forceps** of Brass, with fine points . . .					0	2	6
1961	Ditto ditto Steel and Platinum points .	5s. 6d.	£0	7	6	0	10	6
1962	Ditto **Spoons,** Platinum or Silver . . .	from				0	5	0

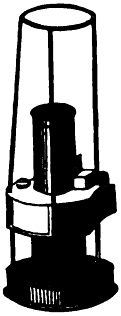


FIG. 2041.

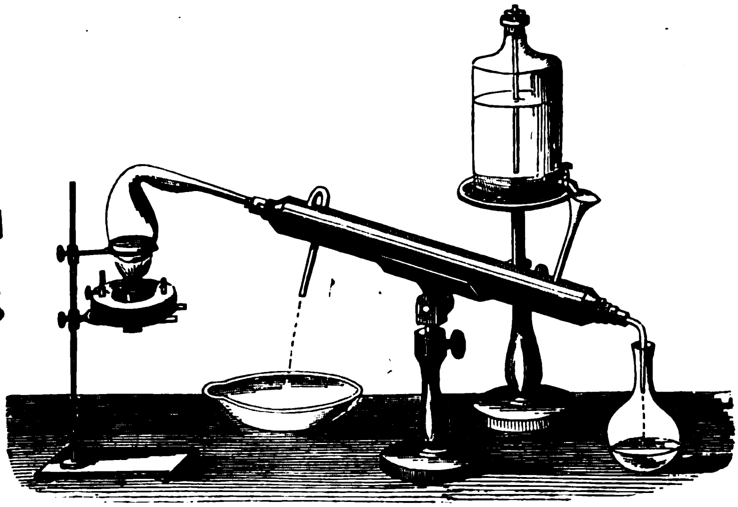


FIG. 1985 and 1986.

			Each. £	s.	d.	Each. £	s.	d.
1963	**Blowpipe Apparatus,** for Pocket, containing requisites for Assaying metals, in case					1	10	0
1964	**Bellows,** portable Double, for table furnaces .	from				1	10	0
1965	**Blowpipe, Mineral Fragments,** per box					0	12	0
1966	**Brass Tobacco Pipe,** for blowing Gas Bubbles . .					0	3	0
1967	**Brushes,** Test Tube	from				0	0	6
1968	Ditto, **Phial and Bottle**	8d.	0	0	10	0	1	6
1969	**Caoutchouc** in sheets					0	1	6
1970	**Caoutchouc Gas Bags,** wedge shape . .	from				1	10	0
1971	Ditto **Connectors,** for joining tube apparatus	from				0	0	2
1972	Ditto, **Vulcanised Tube**	per foot, from	0	0	6	0	2	0
1973	Ditto **Varnish**	per oz.				0	0	4
1974	Ditto **Water Bottles**		0	10	6	1	1	0

1974° **Balance** (fig. 1974) for Assaying, Analysis, or Diamond weighing, will carry 500 grains and turn with $\frac{1}{50}$ of a grain; all bearings of Steel. In plain Glass Case, with key arrangement for lifting . . . £5 5 0

1974† Ditto ditto with Set Screws and Spirit Level . . . £6 6 0

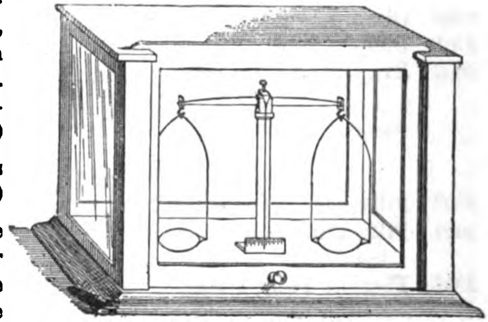


FIG. 1974*.

1974‡ **Balance** for determining the Specific Gravity of Fluids, whether heavier or lighter than water, to the third place of decimals. This Balance consists of weigh-beam, a plunger to be immersed in the fluid; fitted with Thermometer, Set of Weights and Riders, Glass Solution Jar, &c., in wood case. . . . . . . price £4 4 0

No.	Article	Each. £ s. d.	Each. £ s. d.
1974A	**Capsules** of Platinum, Silver, Copper, &c., various.		
1975	**Chauffers** with cover and pipe for increasing heat .	0 9 6	0 12 6
1976	**Chemical Labels**	0 0 8	0 3 0
1977	**Combustion Furnace** of stout Sheet Iron . . .		0 7 6
1978	**Cross** of Four Metals for showing unequal power of conducting heat		0 6 0
1979	**Connecting Pieces, Brass Angle and T Pieces, Union Joints** for uniting Stop-Cocks, &c. . 1s. 1s. 6d.	0 2 6	0 4 6
1980	**Connecting Ferrules, Brass,** for Bladders	0 1 0	0 1 6
1981	**Crucibles,** Platinum, Silver, Iron, &c., various.		
1982	**Crucible Jacket,** iron plate, to hold any size Platinum crucible		0 2 0
1983	**Crucible Stands and Supports,** various	0 0 2	0 0 8
1984	Ditto **Tongs,** straight, bent, &c., of various sizes 1s. 6d.	0 2 6	0 4 6
1985	**Condensers,** Liebig's form for Distillation (fig. 1985) .		0 10 6

The steam passes through a long glass tube, enclosed in an outer metal tube; in the intervening space water is made to flow continuously, and rapid condensation is effected.

No.	Article	Each. £ s. d.	Each. £ s. d.
1986	**Support** for Liebig's Condenser, best make, in black wood, capable of being elevated and inclined to any angle (see fig. 1986)		0 10 6
1987	**Cork Borers,** a set of four, without case		0 2 6
1988	Ditto, of polished brass, set of six, in a case . . .		0 4 6
1989	Ditto, a set of twelve		0 7 6
1990	**Deflagrating Spoon,** the bowl rivetted to the stem, with a sliding cover for the jar (fig. 1990)		0 0 8
1991	Ditto, Ground Cover, to fit the top of Glass Receiver .		0 2 6
1992	**Drying Apparatus,** or Hot Air Bath, on stand, japanned tin, from		1 1 0
1993	Ditto ditto tinned Copper, or Copper	2 2 0	4 4 0
1994	**Decimal Weights,** from 1,000 grains to a 10th of a grain, in mahogany box		1 10 0
1995	Ditto, from 1,000 grains to 1-100th of a grain, the smaller weights of aluminium or platinum . .		2 2 0
1996	**Diamonds,** for Writing and Engraving on glass from		0 10 6
1997	Ditto for Cutting ditto	0 15 6	2 2 0
1998	**Dishes, Evaporating,** Copper . . . . from		0 2 6
1999	Ditto ditto Copper tinned inside . . .		0 3 0
2000	Ditto ditto Copper plated with silver . .		0 6 6
2001	Ditto ditto Silver . . . from		0 7 6
2002	**Evaporating Capsules,** of **Platinum** :—		

Diameter .	½-in.	¾-in.	1-in.	1½-in.	2-in.	2¼-in.	2¾-in.
Contents .	1-16th oz.	1-10th oz.	⅛-oz.	¼-oz.	⅝-oz.	¾-oz.	1½-oz.

Price variable, according to weight, about 35s. per oz.

No.	Article	Each. £ s. d.	Each. £ s. d.
2003	**Files,** for cutting Glass Tube, with wood handle . .		0 1 6
2004	**Files and Rasps,** for fitting Corks to tubes, with wood handle		0 1 6
2005	**Flexible Tube, Metal,** for conducting gases, from per foot		0 0 10
2006	Ditto ditto Vulcanised India Rubber	0 0 6	0 1 0
2007	**Filter Paper,** thick, per lb.		0 1 9

FIG. 2023.

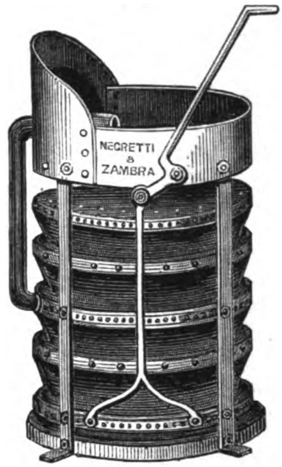


FIG. 2021.

		Each. £	s.	d.	Each. £	s.	d.
2008	**Filter Papers, Circular,** ready cut for use; give a very minute portion of ash, and filter rapidly; in packets of 100 :—						
	Diameter . 2¼-in. 2¾-in. 3¼-in. 4⅜-in. 5⅜-in. 7¼-in.						
	Price per 100 . 3d. 5d. 7d. 8d. 1s. 1s. 4d.						
2009	**Filtering Paper,** superior quality, per quire . . .	0	1	6	0	2	0
2010	Ditto, **Swedish,** per quire				0	3	6
2011	**Filter Paper Boxes,** japanned, holding 200 filters :—						
	For No. 1 2 3 4 5 6 Filters.						
	7d. 8d. 9d. 1s. 1s. 3d. 1s. 6d.						
2012	**Funnels,** Gutta Percha . . . . . . from				0	1	0
2013	Ditto, Tin and Tinned Copper . . . . . „				0	1	6
2014	**Furnaces,** Aikin's blast . . . . „				0	16	6
2015	**Furnaces,** Black's Universal, applicable to the reduction and assay of metallic ores, cupellation of silver, &c.				5	10	0
2016	**Furnaces,** portable Table, Earthen and Black lead, from	1	1	0	1	10	0
2017	Ditto, Black Lead, larger, for retorts or tubes, &c. .	2	2	0	4	4	0
2018	**Furnaces,** round Iron, lined with fire lute or brick, applicable for general chemical purposes . . .	3	3	0	5	5	0
2019	**Furnace Blowers,** see Nos. 1956 and 1964.						
2020	**Forge,** improved single blast. These Forges possess great power, and are very portable . . **Round**	5	5	0	6	6	0
2021	**Forge,** Patent double Deck or Rivet, having large powers of blast, insuring great and rapid heat (fig. 2021) **Round**				8	8	0
2022	**Forge,** improved Portable Iron, adapted for soldering and brazing purposes, jewellers' uses, and suited for amateur mechanics . . . . . . **Square**	5	5	0	6	6	0
2023	**Forge,** portable Iron, improved with double bellows, the whole fitted together with nuts and screws for convenience of packing, arranged with connecting screw and pipe for blast furnaces (fig. 2023) . .				10	10	0

A most useful article for persons residing in foreign parts, or Emigrants.

FIG. 2028.

FIG. 2028*.

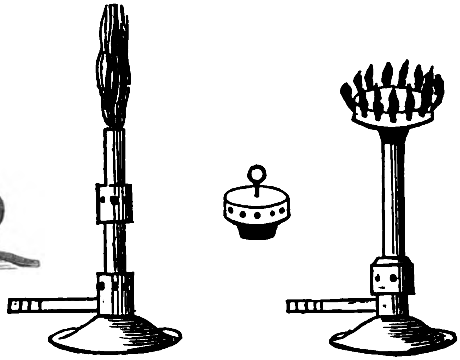


FIG. 2028†.

No.	Article	Each. £ s. d.	Each. £ s. d.
2024	**Gas Apparatus,** complete, for making oxygen and hydrogen in quantities, for Oxy-Hydrogen Microscope (see page 323)		3 3 0
2025	**Gas Retorts,** Copper, with **Conducting Tubes,** for the preparation of Oxygen Gas, without Bags . . .	1 1 0	1 10 0
2026	Ditto, Wrought Iron		1 1 0
2027	Ditto, Iron, small		0 12 6
2028	**Gas Burners, or Furnace** (Bunsen's), adapted for burning common gas, mixed with air, without smoke; for boiling, distilling, &c. (figs. 2028, 2028°, 2028†) 5s. 6d.; 8s. 6d.	0 12 6	0 16 0
2029	**Gas Blowpipes,** see *ante*, page 358.		
2030	**Gas Lamp,** conveniently arranged on bronzed adjusting table stand as a reading lamp, a microscopic illuminating or preparing lamp, and also useful for chemical operations see page 302 (fig. 1406), Microscope Section . . . . price		3 0 0
2031	**Gauge Brass,** for showing the expansion of metals by heat, see also Section Phenomena of Heat . . .		0 6 0
2032	**Grain Scales and Weights,** see pages 355 and 368.		
2033	**Gutta Percha Basins, Funnels, Troughs, Trays, Tube,** &c., &c., ... various sizes and prices		
2034	**Gutta Percha Bottles,** round, for Acids, &c. :— Price . . 2-oz. 1s.; 4-oz. 1s. 4d.; 8-oz. 1s. 6d.; 16-oz. 2s. 6d.		
2035	**Hammers, Mineralogical** . . . . . from		0 6 0
2036	**Furnace Oil-Lamp.**—By the use of very light mineral oil, specific gravity ·750, 4 or 5 lbs. of cast iron may be melted in about sixty minutes		2 0 0

2037 **Furnace, Simple and Powerful,** with the foot blower (fig. 2037), it will melt 6 ozs. of gold, and the same quantity of cast iron in from ten to fifteen minutes. Any ordinary gas supply $\frac{5}{16}$ or $\frac{3}{8}$ pipe will work it efficiently. About 10 cub. ft. per hour is sufficient for most purposes. Crucibles must not exceed the oo size of the Patent Plumbago Crucible Co., 2½ inches by 2 inches. Any common blowpipe bellows will work the furnace satisfactorily except for very high temperatures (fusion of steel, &c.), for which a heavy pressure of air is necessary. Price complete without Blower, 8s. 6d. For Blowers, see page 357, No. 1957.

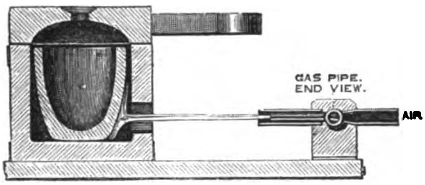


FIG. 2037.

FIG. 2047.

		Each. £ s. d.	Each. £ s. d.
2038	**Blowing Machine** for Oil Lamp Furnace . . .	5 5 0	10 10 0
2039	**Iron Spheres**, strong; this apparatus shows the expansive force in the congelation of water . .		0 4 6
2040	**Ladles**, small Iron . . . . from		0 0 8
2041	**Lamps**, Chemical Argand, with cottons and mandril, complete (fig. 2041) . . . . . . 7s. 6d.	0 8 6	0 10 6
2042	Ditto ditto with double concentric wick . .		1 1 0
2043	**Lamp**, Argand Fountain, with adjusting screws, for fixing on retort stands		0 18 0
2044	**Lamps, Davy's Safety,** for Miners		0 12 0
2045	Ditto Ditto improved (fig. 2045)	0 15 0	1 5 0
2046	Ditto, **Bunsen's for Blowpipe,** with tray . . .		0 7 0
2047	**Lamps,** Spirit, small brass (fig. 2047)		0 6 6
2048	**Lamps,** Spirit, Brass, with two sliding rings, a convenient stand, for small evaporating dishes, &c. . .		0 16 0
2049	**Lamps,** Hydrogen, Dobereiner's, for producing instantaneous light, with a jet of hydrogen . .	1 6 0	1 10 0
2050	**Magnets,** Steel, Horse-shoe shape . . 6d., 9d., 1s.	0 1 6	0 5 0
2051	**Magnetic Oxide of Iron, or Natural Loadstone,** in pieces or slabs . . . . from		0 4 6
2052	**Magnesium Wire** . . . . per yard		0 0 6
2053	**Masks,** of Wire Gauze, for protecting the face . .		0 6 0
2054	**Magnifying Glasses,** Pocket, for examining minerals, crystals &c. (See "Optical Section," page 257) .	0 3 6	0 4 6
2055	**Metallic Vessel,** Leslie's Cube, with polished and blackened surfaces, for showing the absorption and radiation of heat		0 5 6
2056	**Mercurial Troughs,** Iron and Mahogany . from		0 6 0
2057	**Mohr's Burettes,** with support (fig. 2057) . . .		0 16 0
2058	Ditto ditto without stand		0 7 6
2059	**Mortars and Pestles,** of cast Iron . . . . from		0 4 0
2060	**Mortars of Steel,** for crushing hard minerals . .		1 12 0
2061	**Melting Tongs,** for Furnace Work	0 4 6	0 6 6
2061*	**Nippers,** or **Cutting Plyers,** for cutting wire . .	0 2 6	0 3 6

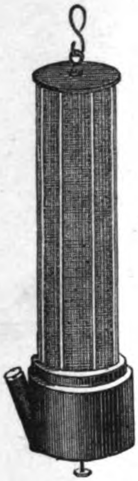


FIG. 1990.

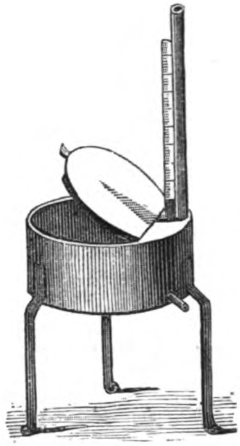


FIG. 2114.

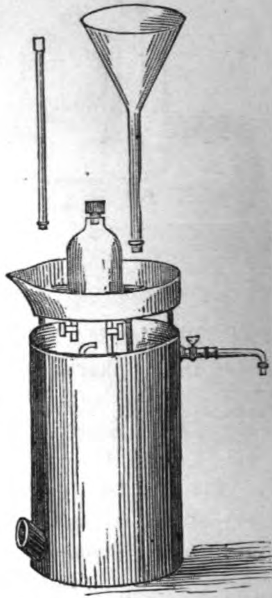


FIG. 2045.

FIG. 2067.

No.	Article	Each. £ s. d.	Each. £ s. d.
2062	**Platinum Crucibles, Basins, and Evaporating Dishes,** various sizes . . . . . . about per. oz.		1 15 0
2063	**Platinum Retorts,** half-pint . . . . . about		11 0 0
2064	Ditto ditto one pint . . . . . "		16 0 0
2065	**Platinum Forceps and Spoons** 1s. 6d. 3s. 5s. 6d.	0 8 0	0 12 0
	No exact prices can be given for Platinum Vessels, as the value varies considerably.		
2066	**Pepy's Gas Holder,** of japanned Tin or zinc, with long pressure funnel, stopcocks and connectors, complete to hold about 2,000 cubic inches		3 0 0
2067	Ditto best mounted, Copper japanned (fig. 2067) with Graduated Gauge Tube		5 5 0
2068	**Pneumatic Troughs,** Japanned Tin, for collecting gases, small size, Round for Tube Experiments . . .		0 7 6
2069	**Pneumatic Troughs,** Oblong Shape, 1st size . . .		0 10 6
2070	Ditto ditto 2nd size		0 12 6
2071	Ditto ditto 3rd size . . . . .(fig. 2071)		0 18 6
2072	**Pneumatic Troughs,** of any size or shape, made to order, in Copper, Tin, or Zinc, &c.		
2073	**Reflectors,** highly polished metallic, for experiments on radiant heat . . . . . . from, per pair		1 10 0
2074	Ditto, Plated Copper . . . . from		2 2 0
2075	Ditto, **Stands,** for Reflectors and Iron Ball	0 6 0	0 8 0
2076	**Retorts,** Lead, for Fluoric Acid, 16 oz.		0 10 6
2077	**Retort Stands,** small Iron foot . . . . from		0 2 6

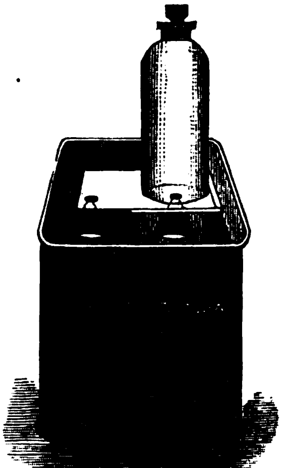


FIG. 2071.

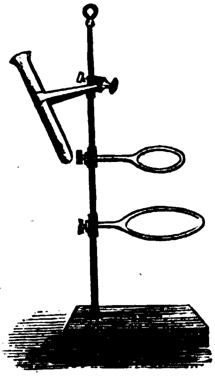


FIG. 2078.

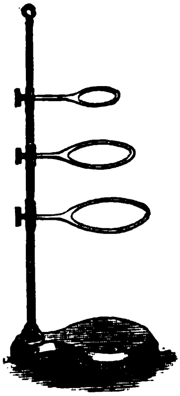


FIG. 2078*.

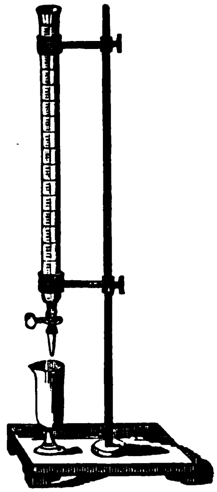
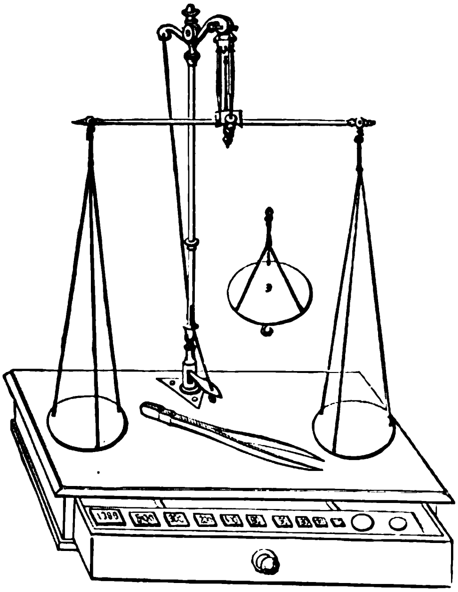


FIG. 2057.

		Each. £	s.	d.	Each. £	s.	d.
2078	**Retort Stands,** Iron foot and rod, 2 and 3 rings (fig. 2078 and 2078*) . . . . . 2s. 6d., 5s.	0	7	6	0	14	0
2079	Ditto ditto Brass, large, with heavy foot (fig. *f*) page 333	0	16	0	0	18	6
2080	Ditto ditto large with Fountain, Argand Oil Lamp, and three rings				1	15	6
2081	**Sand Baths,** small round Copper, for retort stands .	0	1	6	0	2	6
2082	Ditto ditto, in Copper and Iron, of various forms and sizes, for Furnaces.						
2083	**Stands or Supports** for ditto Tripod (fig. 2083) . .				0	7	6
2084	**Scales and Weights, Pocket** (fig. 1923), for Diamonds or Gold dust	1	6	0	1	10	0
2085	**Scales,** for weighing Gold, Silver, Gold dust, or Diamonds, &c., with Troy Weights (fig. 1926) £1 10s.	2	2	0	3	10	0
2086	**Scales and Weights,** large, to stand on Counter or Table, for the rougher uses of the laboratory £1 1s.	2	2	0	3	10	0
2087	Ditto ditto of greater precision, with Decimal Weights, &c. (fig. 1927)	3	3	0	4	4	0
2088	**Scales,** Chemical (see Balances, page 355 and 359.)						
2089	**Scales,** Bullion, to weigh 300, 500, 1,000 to 2,000 ozs. £30, £40, £60, and £70.						
2090	**Shears,** Cutting, small	0	2	6	0	5	0
2091	**Sieves,** of hair, lawn, and wire, for straining or sifting .	0	1	6	0	4	6
2092	**Spatulas,** Steel, with handles . . . . from				0	1	0
2093	Ditto Platinum . . . . . . „				1	12	0
2094	Ditto Silver . . . . „				0	10	0



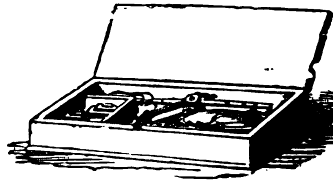


FIG. 1923.

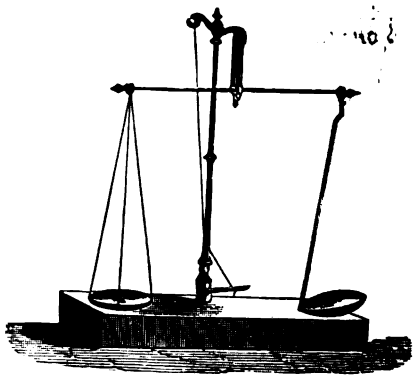


FIG. 1927.

FIG. 1926.

No.	Article	Each. £ s. d.	Each. £ s. d.
2095	**Still, Working Model,** of Copper, handsomely japanned, suitable for the Lecture Table (fig. 2095) . . .	1 15 0	2 2 0
2096	**Stills,** small, of strong tin, with Argand Lamp and Worm Tube, 1 quart		0 11 0
2097	Ditto ditto 2 quarts		0 15 6
2098	**Stills,** portable, Strong Tin, with worm and tub, for preparing pure water for Chemical or photographic purposes, for use on an ordinary fire, 1 gallon (fig. 2098)	1 6 0	1 10 0

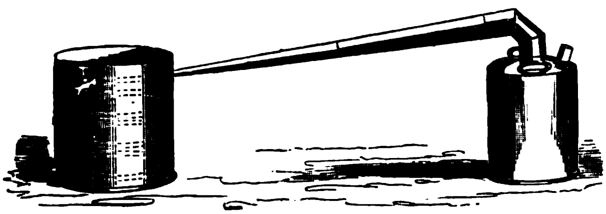


FIG. 2098.

FIG. 2098*.

2099	**Stills,** Strong Tin, portable, 2 gallons		2 2 0
2100	Ditto, Copper, 1 gallon and 2 gallons	2 2 0	2 10 0
2101	**Stills,** Copper, best make, Portable Iron Frame and furnace, with pewter worm and tub, 2 gals. . .		5 5 0
2102	Ditto ditto 5 gals.		8 8 0
2103	Ditto ditto 10 gals.		13 13 0
2104	**Distilling Apparatus** for ascertaining the Original Gravity of Beer after fermentation, or Alcoholic Wine Test, see page 168.		

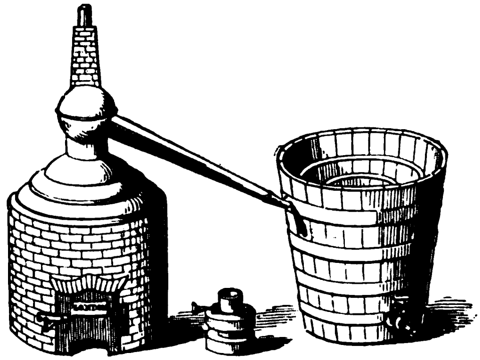
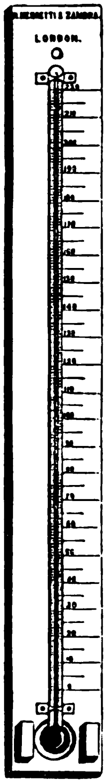


FIG. 2095.

		Each. £ s. d.	Each. £ s. d.
2105	**Stopcocks,** common Brass		0 2 6
2106	Ditto, **Best** make, Brass		0 3 6
2107	Ditto, Iron, small		0 6 0
2108	**Syphon,** Pewter and Copper . . . . . from		0 7 6
2109	Ditto ditto with Stopcock . . . . „		0 10 6
2110	**Syringes,** Exhausting or Condensing (see also Pneumatic Apparatus)		0 10 6
2111	**Supports** various, for Tubes, Retorts, Receivers, &c. 3s. 6d.	0 5 0	0 14 0
2112	**Taper Holder,** of wire, for experiments in Oxygen Gas, &c. (fig. 1990, the wire only)		0 0 6
2113	**Taylor's Hot Air Bath,** stout sheet Iron, with double body and bottom, and long chimney		0 16 0
2114	Ditto ditto, Copper (fig. 2114)		1 15 0
2115	**Test Papers,** red or blue litmus, and turmeric, per book		0 0 2
2116	Ditto neutral (reddened by acids and turned blue by alkalies), very delicate . . . . . per book		0 0 2
2117	**Test Tube Brushes,** tipped with sponge	0 0 6	0 1 0
2118	**Test Tube Holders**		0 0 8
2119	**Test Tube Stands,** for eight test tubes, with draining pegs (fig. 2119)		0 1 8
2120	Ditto ditto for twelve test tubes, with draining pegs		0 3 6
2121	**Test Tube Stands,** of Mahogany polished, with double set of holes, for twenty-four and thirty-six test tubes	0 5 0	0 6 6
2122	**Thermometer, Standard** (fig. 2122)		2 2 0
2123	Ditto **Chemical,** with plain exposed bulb, graduated to 300° (fig. 2123)		0 5 6
2124	Ditto ditto with Brass Hinged Joint to scale (fig. 2124)	0 10 6	0 12 6
2125	**Thermometers,** Isolated for dipping in Acids, &c. (figs. 2125 and 2125*) (see also pages 136 and 137) . . .	0 7 6	0 10 6
2126	**Thermometers,** with bent tube, for Hot Air Bath, Drying Chambers, &c. (fig. 2126)		0 10 6
2127	**Tubing,** Vulcanised India Rubber, per foot, 4d., 6d., 8d.,	0 1 3	0 2 0
2128	**Vice,** to fasten to Table	0 10 6	0 18 0
2129	**Wire Gauze,** of various sizes, for experiments on Flame.		



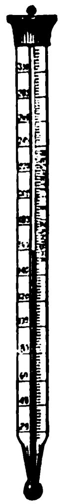


FIG. 2125*.

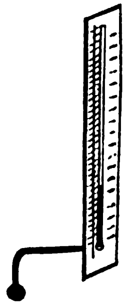


FIG. 2126.

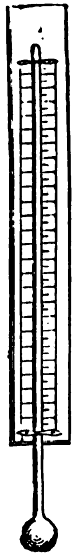


FIG. 2123.

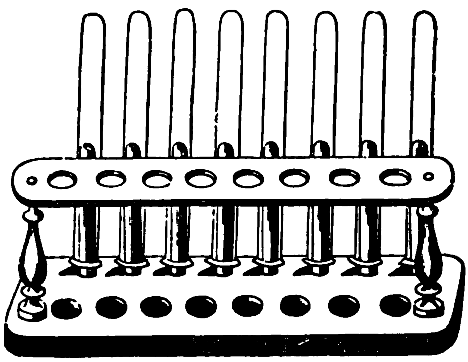


FIG. 2122. FIG. 2125. FIG. 2119. FIG. 2124.

		£ s. d.	£ s. d.
2130	**Weights,** Grains and Drachms . . per set, each		0 0 6
2131	Ditto Platinum, grains . . . per set		0 3 6
2132	Ditto Aluminium, 1 grain to 1-10th		0 3 6
2133	Ditto Brass, 1,000 grains to 1·100th . . .		2 0 0
2134	Ditto ditto 50 Grammes to 1 Milligramme .		1 18 0
2135	**Weights,** Sets of **Troy,** for above, 10 ozs. to $\frac{1}{10}$th of an ounce		3 10 0
2136	Sets of ditto ditto 20, 30, 40, 50, and 100 oz. . . .		5 10 0
2137	**Standard Grain Weights,** in mahogany box, containing 10,000, 6,000, 3,000, 2,000, 1,000, 600, 500, 300, 200, 100, 60, 30, 20, 10, 6, 3, 2, 1, ·6, ·3, ·2, ·1, ·06, ·03, ·02, ·01 .		4 4 0
2138	**Standard Grain Weights,** smaller set	3 13 0	2 2 0

Weights Decimal, see page 360.

FIG. 2140.

CHEMICAL CABINETS AND PORTABLE LABORATORIES.

2139 **Youth's Chemical Cabinet,** containing sixty chemical preparations, and useful apparatus, without deleterious and dangerous articles; and adapted for exciting a taste for chemistry in the young. No. 1, in paper case £0 5 6

2140 **Youth's Chemical Cabinet,** No. 2, in cedar case, with hook fastening (fig. 2140) £0 7 6

2141 Ditto ditto No. 3, in stout mahogany case, French polished, and with lock and key (fig. 2140) 0 10 6

2142 **First Steps in Chemistry and Companion to the Youth's Chemical Cabinet;** containing a series of select, amusing, and instructive chemical experiments £0 0 6

FIG. 2144.

2143 **Student's Chemical Cabinets,** containing a larger assortment of apparatus, in mahogany cabinets, with lock and key . £1 1 0 £1 11 6 £2 2 0

2144 **Student's Chemical Cabinet** (fig. 2144), a good useful working chest; it contains upwards of 79 chemical preparations and re-agents, and a large assortment of apparatus, &c., in a mahogany cabinet, with lock and key £3 3 0

2145 **Student's Chemical Cabinet,** No. 5, contains the necessary re-agents and instruments for the various operations of qualitative analysis, testing in the humid way, and includes blow-pipe apparatus, fluxes, and tests for the discrimination of ores, minerals, &c. The apparatus, &c., is conveniently arranged in a mahogany cabinet, with drawer, tray, lock and key £8 8 0

2146 **Agricultural Test Chests,** fitted with re-agents and apparatus for the qualitative analysis of soils, manures, &c. The tests are pure, and the apparatus of a useful size, carefully arranged in a cabinet, with lock, key, &c. £3 3 0 £5 5 0 £8 8 0

2147 **Toxicological Test Chests,** contains all the re-agents and apparatus necessary for the accurate analysis of any substance suspected of containing poison, in accordance with the present advanced state of this branch of chemical science £5 5 0

These Chemical Cabinets and Portable Laboratories are specially arranged for the use of persons who have not convenient space for keeping such apparatus, or where portability combined with security is important. In all other cases, where ample and secure space can be devoted to the purpose, Messrs. Negretti and Zambra would recommend one of the following Sets of Apparatus, or purchasers to make their own selection from our Chemical Section.

SETS OF CHEMICAL APPARATUS FOR ELEMENTARY EXPERIMENTS.

Adapted for illustrating the Theory and Practice of Chemistry, the Production and Examination of Gases, &c., &c.; suitable for Students studying Elementary Chemistry, and for verifying the main facts on which the Science is based.

2148 **Three Guinea Set of Apparatus.** Retort Stand, with three sliding rings; Two two-ounce retorts; Two half-pint retorts; Globular receiver; Black's blowpipe; Nest of Hessian crucibles; Apparatus for making oxygen gas over a spirit lamp; Glass Spirit Lamp; Gas bottle, with acid funnel and delivery tube, for making hydrogen gas, &c.; Balloon for hydrogen gas; an assortment of six flasks, for solutions, digestions, &c.; Gas bottle, with bent delivery tube, for making chlorine and other gases; Pipette or dropping tube, &c.; Book test papers; Set of six cork borers, with file for sharpening them, and steel rod, in japanned case; Glass funnel, and supply of filtering paper; Funnel support, with moveable arm; Balance, with a set of weights, from ¼ oz. to ½ grain, in box; Tall test glass, for precipitations; Two Clark's test glasses, for testing, &c.; Six Test tubes, of hard German glass; Test tube stand; Two stirring rods; Glass tubing, for fitting up gas bottles, for conducting tubes, &c.; Pneumatic trough, with moveable shelf and tray: Two gas jars; One gas jar, with glass stopper; One transfer jar, mounted with brass cap, stopcock, bladder and bladder piece, and brass jet; Two porcelain evaporating basins; Graduated glass measure; Deflagrating ladle, with cover; Two watch glasses, for evaporations, &c.; File for cutting glass tubing; Glass plates, Porcelain mortar. Including a strong Packing Case.

2149 **Five Guinea Set of Apparatus.** Retort Stand, with iron foot and rod, and three sliding rings; Two plain retorts; Two tubulated retorts, one receiver; Set of four porcelain capsules, for evaporations, crystallizations, &c.; Pneumatic trough, with moveable shelf and tray; Bell or transfer jar, mounted with brass cap and stopcock; Bladder, mounted with ferrule; One brass jet, for experiments on oxygen; Pestle and Mortar; Glass tubing; Half-a-dozen glass stirrers; Two glass funnels, filtering paper; Three flasks, for solutions, digestions, &c.; Bars of zinc, copper, and iron, for use in testing, &c.; Two books of neutral test papers; One dozen hard German glass test tubes; Test tube stand for one dozen tubes; Tall test glass, for precipitations; Two Clark's test glasses, for testing, &c.; Black's blowpipe; Blowpipe lamp; Clark's gas bottle, for making sulphuretted hydrogen, &c.; Gas bottle, with bent glass delivery tube, for preparing chlorine and other gases; Platinum foil and wire; Glass spirit lamp; Graduated glass measure, 4 oz.; Pipette; Improved apparatus for making oxygen over a spirit lamp; Cylinder, for supporting flasks, basins, &c.; Sand bath iron; Two watch glasses; Set of cork borers, in case; Two files, one for cutting glass tubing, and the other for enlarging holes in corks, balance and set of weights; Nest of Hessian crucibles. Including a strong Packing Case.

PURE CHEMICALS, TESTS, OR RE-AGENTS SUPPLIED IN ANY QUANTITY AT THE LOWEST MARKET PRICES.

ELECTRICITY.

"The peculiar and invisible agency, which we term Electricity, is one of those hidden and mysterious powers of nature which has become known to us through the medium of effects: our first acquaintance with it appears to have arisen out of a curious but simple fact, noticed full 600 years before the Christian era. Thales, of Miletus, a celebrated Greek philosopher, the founder of the Ionic Philosophy, observed as a remarkable property of Amber its power of attracting light particles of matter on being subjected to excitation by friction, and with which he is said to have been so struck, that he imagined the amber to be endowed with a species of animation. Theophrastus, about 300 years before the Christian era, observed a similiar property in a hard stone termed the *lyncurium*, now supposed to have been the Tourmaline, which he says will, not only attract light straws and sticks, but even thin pieces of metal. Pliny and other naturalists also notice this property of Amber; and a similar property is said to have been discovered at an early period in Agate."

"The attractive property developed in Amber by the process of friction may be considered as the source of the nomenclature of this branch of science. The Greek word expressive of amber being *Electron*, in Latin Electrum, the unknown principle, or element, with which Thales supposed it to be animated, has been termed Electricity. As our knowledge of such phenomena advanced, and other substances were observed to possess similar properties, they were considered as being *amber-like*, were said to be *electrical*, and were hence termed Electrics."

"The first apparatus that was constructed for the exhibition of electrical phenomena, to which the name of *electrical machine* was given, was the globe of sulphur used by Boyle and Otto Guericke Burgomaster of Magdeburg, with which they discovered electric light. The substitution of glass for sulphur was made by Newton, the rubbers employed in both cases being the hand of the operator. That important part of the machine called the *prime conductor* was first introduced by Boze; it consisted of an iron tube suspended by silken strings: and the substitution of a cushion for applying friction in the place of the hand, was first made by Winkler. Various were the forms now given to the electrical machine, for descriptions of many of which the curious reader is referred to Priestley's compendious *History of Electricity*, 1769. Dr. Watson's machine consisted of four globes turned by the same multiplying wheel, the electricity being collected by one common conductor, and Dr. Priestley seems to have been the first electrician who employed a conductor supported by an insulating pillar. It was a hollow vessel of polished copper in the form of a pear. The insulating support was of baked wood, which was preferred to glass, as being a better insulator and less brittle. The conductor received its fire by means of a long arched wire, or rod of very soft brass, easily bent into any shape, and raised higher or lower as the globe required, and it terminated in an open ring, in which were hung some sharp-pointed wires playing lightly on the globe when in motion. The rubber consisted of a hollow piece of copper filled with horse-hair, and covered with basil skin; on it was laid an amalgam made by rubbing together mercury and thin pieces of lead or tin-foil on the palm of the hand, and then mixing it into a paste with a little tallow. The electric was a glass globe with a single neck enclosed in a deep brass cup, mounted in a frame of baked wood, and turned by a large multiplying wheel. The battery employed by Priestley consisted of sixty-four flint green glass jars, each ten inches long and two inches and a half in diameter; the coated part of each was half a square foot; the whole battery contained thirty-two square feet."

"The electrical machines now constructed are exceedingly elegant pieces of philosophical apparatus, though they differ in form and arrangement almost as widely as the somewhat clumsy machines of the older electricians."

ELECTRICAL, GALVANIC, MAGNETIC, ELECTRO-MAGNETIC, AND THERMO-ELECTRIC APPARATUS.

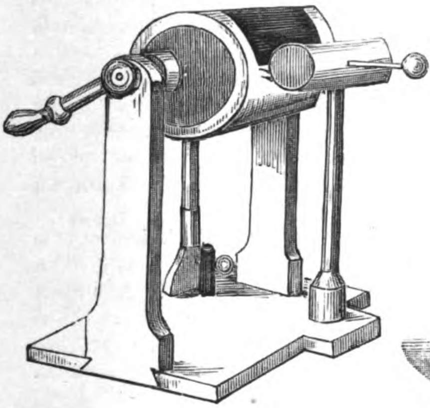


FIG. 2154.

FIG. 2178.

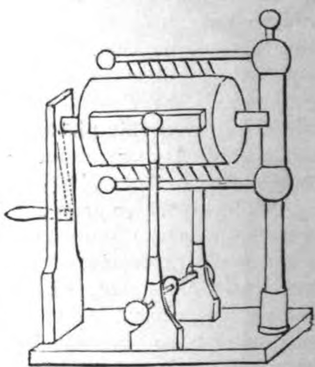


FIG. 2156.

FRICTIONAL ELECTRICITY.

No.	Description	Each. £ s. d.	Each. £ s. d.
2150	**Cylinder Electrical Machines (Nairne's Model)**, on Mahogany Stands, with Japanned Conductors	1 1 0	1 5 0
2151	Ditto with Brass Conductor		1 10 0
2152	Ditto second size, 6-in. by 4-in.		1 10 0
2153	Ditto third size, 7-in. by 5-in.		2 2 0
2154	Ditto fourth size, 8-in. by 6-in. (fig. 2154)		3 3 0
2155	Ditto fifth size, 10-in. by 8-in.		5 5 0
2156	**Cylinder Electrical Machine**, with double rubbers and collecting forks, brass conductors, French polished mahogany stand (fig. 2156)	6 6 0	10 10 0
2157	**Cylinder Electrical Machines**, with a selection of the most instructive and interesting experiments with frictional electricity, Packed in a neat case . £4 4s.	5 5 0	10 10 0
2158	**Plate Electrical Machines** (Ramsden's arrangement, 1760) with Brass Conductor, mounted on polished Mahogany Frames, and finished in a superior manner.		
2159	Ditto 9-inch		1 12 0
2160	Ditto 9-inch		3 3 0
2161	Ditto 12-inch		4 10 0
2162	Ditto 12-inch, Plate Electrical Machine with Double Receiving Forks, best make		5 10 0
2163	Ditto 15-inch with ditto		6 10 0
2164	Ditto 18-inch (fig. 2164) with ditto		8 8 0
2165	Ditto 24-inch ditto		11 11 0

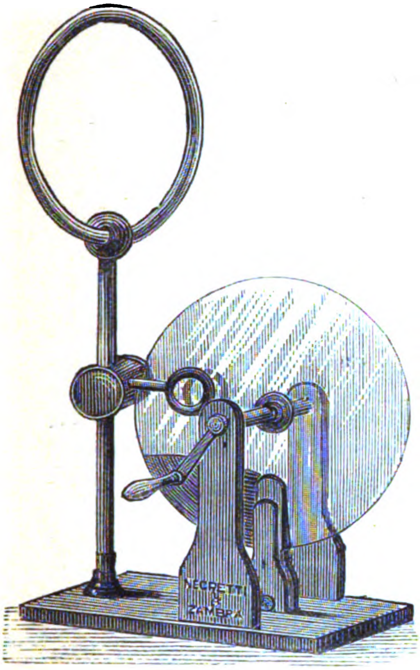


Fig. 2166.

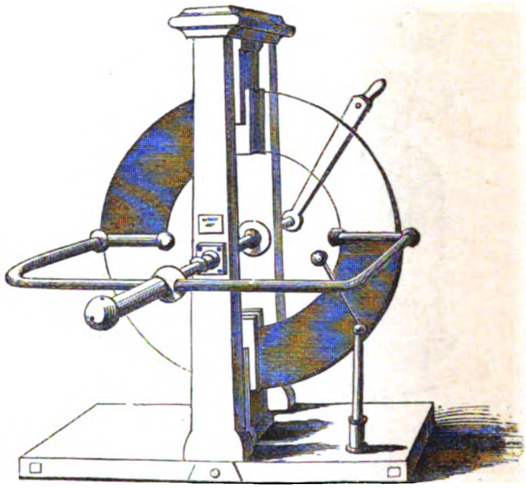


Fig. 2164.

No.	Description	Each. £ s. d.	Each. £ s. d.
2166	**Plate Electrical Machine.**—Winter's arrangement. The Plate in this machine is mounted upon an insulating Glass axis; this, in connection with a large wood covered metal circle placed on top of the prime conductor, considerably increases the length of spark; from a 15-inch plate 6 to 8-inch sparks may be readily obtained (fig. 2166) . . . . price		5 10 0
2167	**Woodward's Double 18-inch Plate Electrical Machine,** a very splendid and powerful instrument		17 17 0
2168	Ditto 24-inch		26 0 0
2169	**Holtz' Electrical Machine,** with 22-inch Vulcanite Plate		20 0 0
2170	**Holtz Machine,** mounted with 2 moveable Plates .		25 0 0
2171	**Plate Electrical Machines,** with a selection of Apparatus for exhibiting the most popular and interesting experiments in Frictional Electricity, Packed in a deal case, with lock and key . . . £6 6s.	10 10 0	20 0 0
2172	**Volta's Electrophorus,** for obtaining the electric spark, a very useful instrument for the laboratory, Resin Base with Brass Plate . . . . from		0 12 6
2173	**Electrophorous,** cheap arrangement, 12-inch disc of Gutta Percha, and 10-inch disc of Tin Plate with a Glass Handle		0 8 6
2174	**Electrophorus Improved,** with Vulcanite or Ebonite Base, with Brass Plate (fig. 2174) . 5-inch, £1 8s.	9-inch,	2 2 0
2175	**Cannon Electrophorus,** mounted with an electrical cannon, for firing mixtures of hydrogen and atmospheric air (fig. 2175)		2 12 6

FIG. 2196.

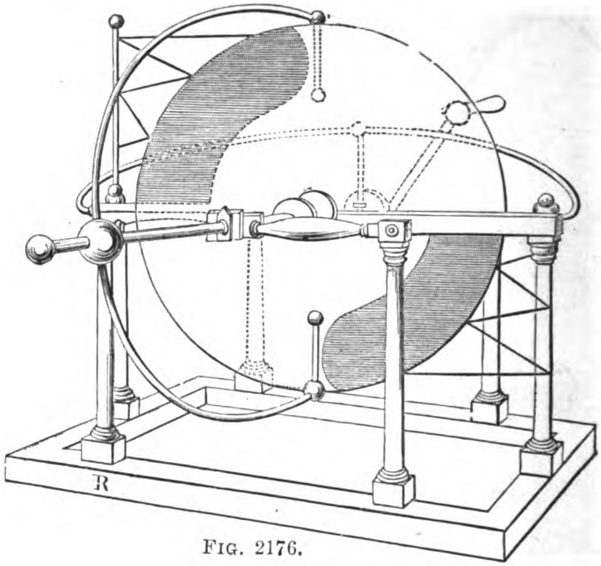


FIG. 2176.

2176 **Harris's 24-inch Plate Electrical Machine,** mounted with Brass Negative and Positive Conductors (fig. 2176) £22 0 0

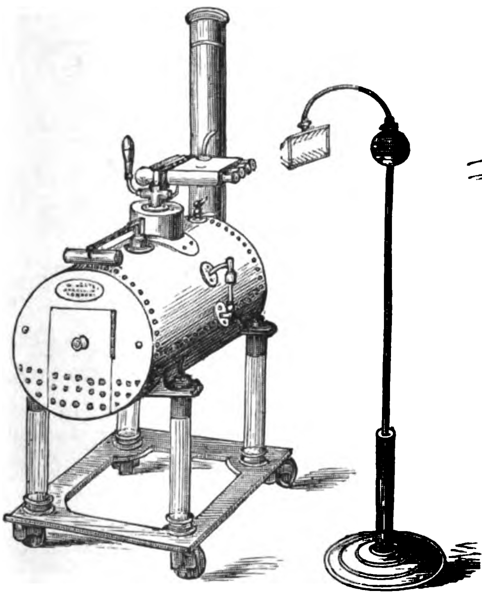


FIG. 2177.

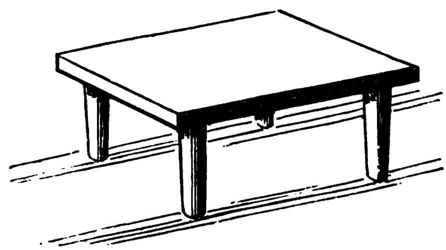


FIG. 2212.

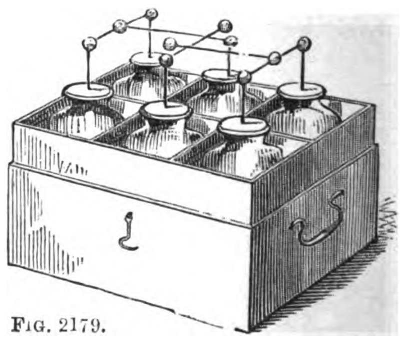


FIG. 2179.

2177 **Armstrong's Hydro-electric Machine** (fig. 2177) £40 0 0

This apparatus consists of a very strong boiler, constructed to sustain great pressure, for evolving Electricity by the friction of water and steam against other substances. It is fitted with safety valve, water gauge, condensing tubes, jets, collecting and discharging rods, &c. The boiler is heated by a coke or charcoal fire, and supported on insulating glass legs and rolling castors, so that the machine can be conveniently moved about.

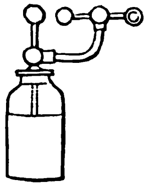


FIG. 2180.

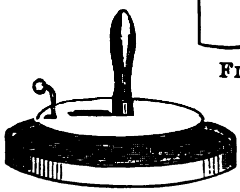


FIG. 2174.

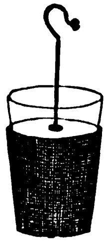


FIG. 2181.

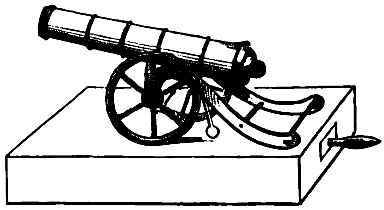


FIG. 2175.

No.	Article	Each. £ s. d.	Each. £ s. d.
2178	**Leyden Jars** (fig. 2178)— Contents . ¼-pint. ½-pint. 1-pint. 2-pints. 4-pints. Price . 2s. 6d. 3s. 6d. 6s. 8s. 6d. 15s.		
2179	**Electrical Batteries**, consisting of 4, 6, 9, 12, or more Leyden jars, mounted in frames or cases, with brass conducting rods and balls (fig. 2179) £2 10s.; £3 3s.	6 6 0	10 10 0
2180	**Medical Leyden Jars**, mounted with Lane's Discharging Electrometer, to regulate the intensity of the shock given to a patient (fig. 2180)	0 12 6	0 18 6
2181	**Leyden Jars**, mounted, to show that the charge is not in the coatings, as those with which it is charged can be removed, and others put in their place, the glass retaining the electricity (fig. 2181)		0 16 6
2182	**Jointed Dischargers**, with glass handles, for discharging electrical jars, batteries, &c. (fig. 2182) . 8s. 6d.	0 11 6	1 1 0
2183	Ditto ditto **French** pattern, with two glass handles (fig. 2183)	0 15 0	1 4 0
2184	**Small Discharging Rods**, not jointed	0 3 6	0 5 0
2185	**Medical Electrical Directors**, with glass handles, for passing a shock through any part of the body (figs. 2185 and 2185*) . . . . . . 3s. 6d.	0 5 6	0 7 6
2186	**Electrical Directors**, for the Eye and Ear (figs. 2186 and 2186*)	0 10 6	0 12 6

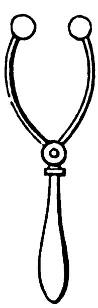
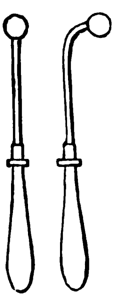


FIG. 2182.



FIGS. 2185, 2185*.

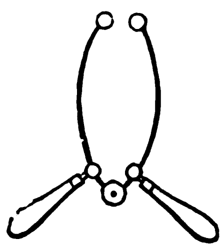


FIG. 2183.

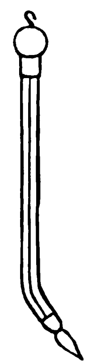


FIG. 2186.

FIG. 2186*.

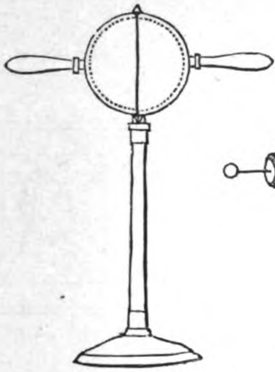


FIG. 2189.

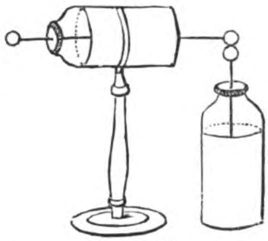


FIG. 2187.

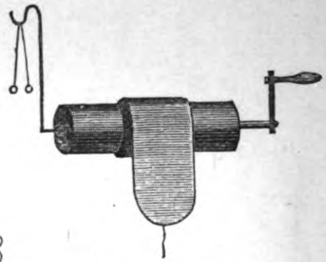


FIG. 2190.

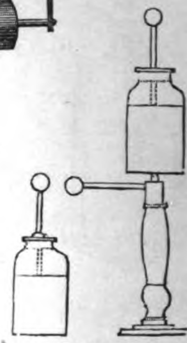


FIG. 2188.

No.		Each. £ s. d.
2187	**Two Jars,** mounted, for explaining the Franklinian theory (fig. 2187)	0 14 0
2188	Ditto ditto, with Insulated Stand, ball and wire (fig. 2188)	1 4 0
2189	**Biot's Apparatus,** for illustrating the distribution of electricity on the surface of insulated conducting bodies. It consists of a sphere of copper, supported on an insulating glass rod and stand, and two thin copper hemispheres of such a size as to enclose the sphere. The covers are fitted with glass handles, so that they can be removed from or placed over the sphere, without the hands touching the metal (fig. 2189)	2 15 0
2190	**Metal Roller,** with Glass Handle and a roll of Tin Foil, mounted upon an Insulating Stand, to show the effect of an expansion of surface in reducing the intensity of electricity whilst the absolute quantity remains the same (fig. 2190)	1 12 6
2190*	**Electrometer, Coulomb's Torsion.** This instrument measures very minute quantities of electricity, and with careful manipulation will give accurate values of the attractive and repulsive force of free electricity communicated to any body of known area	3 3 0
2191	**Henly's Universal Discharger,** with press and table, for deflagrating the metals by electricity, or exposing various substances to electrical action.	1 12 6
2192	Ditto, with **Carbon Forceps,** &c., adapted for Frictional or Voltaic Electricity (fig. 2192)	2 2 0

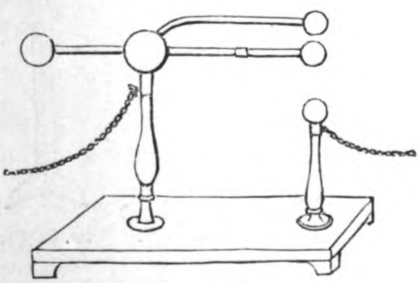


FIG. 2193.

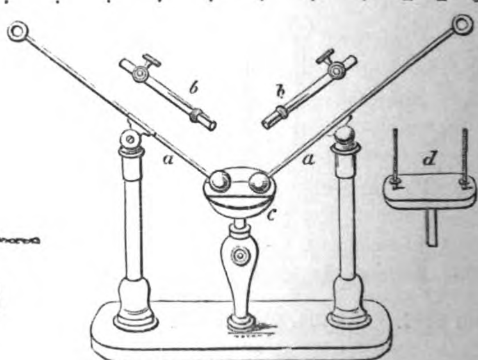
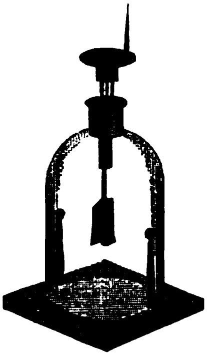
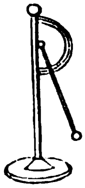


FIG. 2192.

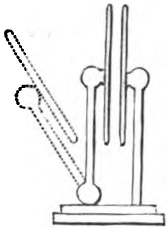
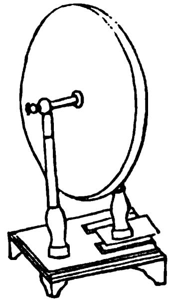




FIG. 2195. FIG. 2197. FIG. 2198. FIG. 2208. FIG. 2209. FIG. 2210.

No.	Description	Each. £	s.	d.	Each. £	s.	d.
2193	**Cuthbertson's Self-acting Balance or Steelyard Discharger** (fig. 2128), for indicating the force or strength of the discharge from an electric battery by the position of the shifting weight on the graduated balance arm				2	15	6
2194	**Balance Electrometer,** or Electroscope, very simple and delicate. It consists of a light metal rod suspended on a point, insulated on a glass stand. The rod is mounted with pith balls on each end, which will be attracted or repelled according to the quality of the electricity affecting it				0	11	0
2195	**Bennet's Gold Leaf Electroscope** (Singer's improved form): used for showing very minute quantities of electricity (fig. 2195). See also page 93	1	1	0	1	10	0
2196	**Volta's Condensing Electroscope** (fig. 2196), see page 385.						
2197	**Henly's Quadrant Electrometer,** with graduated arc, for experiments with accumulated electricity (fig. 2197) .	0	7	6	0	10	6
2198	**Cavallo's Pith Ball Electroscope,** with stopcock for exhaustion (fig. 2198)				1	8	6
2199	**De Luc's Electric Column or Pile,** composed of discs of silver, zinc, and paper, mounted glass tubes with brass caps at the ends	1	14	0	3	3	0
2200	**Zamboni's Electric Pile.** The elements in this pile are silver, black oxide of manganese, and paper, insulated with sulphur: it is more energetic than De Luc's; mounted in glass tubes, terminated with brass caps .	1	10	0	3	3	0
2201	**Bohenburger's single leaf Electroscope,** for ascertaining the presence and quality of very feeble electrical currents (fig. 2201). See page 94. . . .				8	8	0
2202	**Peltier's Electrometer** (or Dr. J. Milner's, 1733) for measuring the tension of electricity by the deflection of a needle; an extremely sensitive instrument (fig. 2202)	5	5	0	4	4	0
2203	**Harris's Balance Beam Electrometer,** for estimating in grain weights the attractive power exerted between two oppositely electrified surfaces				4	4	0

FIG. 2205.

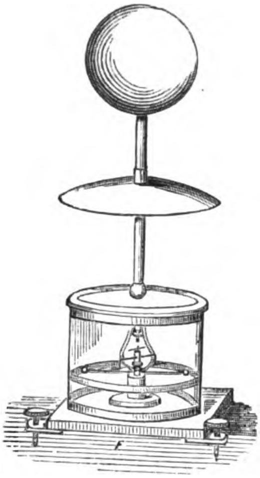


FIG. 2202.

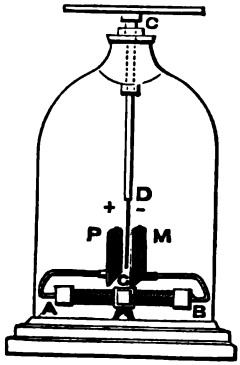


FIG. 2201.

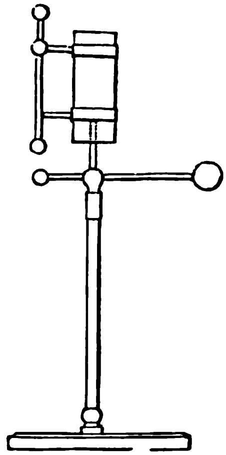


FIG. 2204.

		Each. £	s.	d.
2204	**Harris's Unit Jar Electrometer,** with graduated slider, for charging Leyden jars, or batteries, with known quantities of electricity (fig. 2204)	1	15	0
2205	**Saussure's Electroscope,** for experiments on atmospheric electricity (fig. 2205)	1	5	0
2206	**Harris's Electro-Thermometer,** for measuring the heating power of electricity	1	16	0
2207	**Calorometer, Hare's,** or jointed insulated forceps, for conveniently supporting wires, through which it is wished to pass an electric current, to ascertain the heating power by the length of wire heated (fig. 2207)	1	10	0
2208	**Electrical Condenser,** consisting of two brass plates, one supported on a glass insulating stem, the other resting upon a conducting stem jointed at the bottom (fig. 2208)	0	18	0

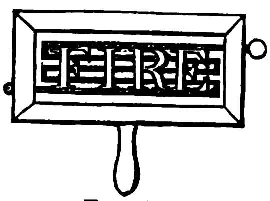


FIG. 2214.

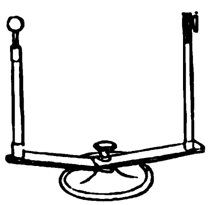


FIG. 2207.

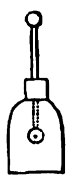


FIG. 2227.

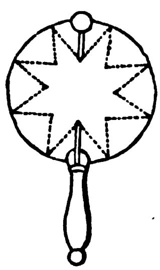


FIG. 2215.

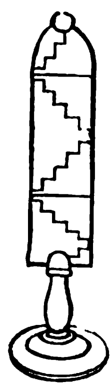


FIG. 2217.

FIG. 2220.

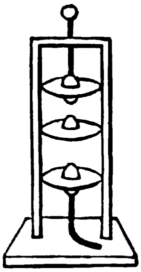
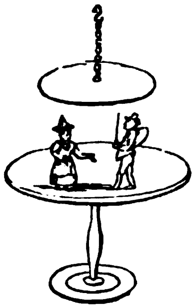
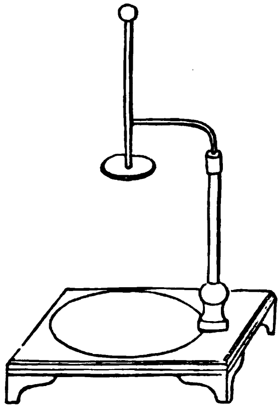
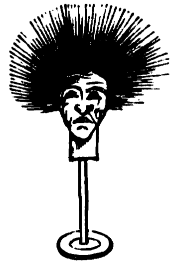





FIG. 2221. FIG. 2223. FIG. 2224. FIG. 2229.

No.	Article	Each. £ s. d.	Each. £ s. d.
2209	**Improved Electrical Condenser and Apparatus,** for experiments upon disguised or paralysed electricity, arranged to connect with a gold leaf electroscope (fig. 2209)		2 2 0
2210	**Magic Picture,** or Fulminating Pane, in frame, for giving slight shocks (fig. 2210)	0 7 6	0 10 6
2211	**Insulated Stools,** for Medical and other purposes, where it is required to insulate a body from the ground .	0 10 6	0 16 0
2212	Ditto, with Mahogany tops (fig. 2212) see page 374 .	1 1 0	1 10 0
2213	**Insulated Adjusting Table Stand,** with hollow Glass support, best make (fig. 2213) see page 385 . .		0 10 6
2214	**Names or Words,** arranged upon glass, with pieces of tin foil, which may be rendered luminous in the dark by the agency of electricity (fig. 2214) . 7s. 6d.	0 10 6	1 5 0
2215	**Star,** formed of spangles of tin foil, on a flat glass (fig. 2215) . . . . from		0 5 6
2216	**Bird,** formed of spangles of tin foil, on a flat glass from		0 5 6
2217	**Painted Glass Plane,** on Stand, in different colours, with devices of tin foil, for showing the electric light (fig. 2217)		0 14 0
2218	**Lightning Plate—De Londe's**—is constructed of a plate of glass mounted upon a firm base; one side of the glass is entirely coated with tin foil to within a short distance of its edge, and the opposite side is covered within small spangles of tin foil placed at a short distance from each other. This forms a modified Leyden jar: when charging the plate, the electricity darts about its surface in all directions, and when discharged a brilliant display of electric light is produced	1 1 0	2 2 0
2219	**Iron Chain** for illuminating a darkened room by electricity . . . . per yard		0 0 6
2220	**Diamond Spotted Jars,** showing a beautiful light when discharged in a dark room (fig. 2220) . . 8s. 6d.	0 15 0	1 10 0
2221	**Egg Stand,** for exhibiting eggs, &c., rendered luminous during the passage of electricity (fig. 2221) . . .	0 8 6	0 16 0
2222	**Faraday's Improved Egg-Stand,** with Glass Cylinder .		0 15 0

FIG. 2230.

FIG. 2231.

FIG. 2234.

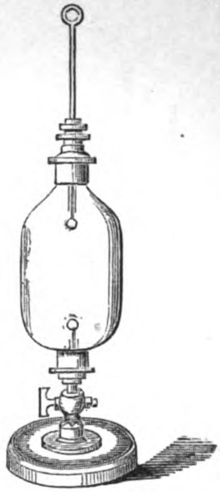


FIG. 2235.

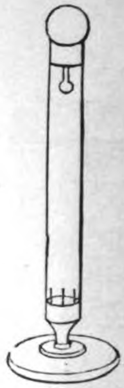


FIG. 2236.

FIG. 2239.

No.	Description	Each. £ s. d.	Each. £ s. d.
2223	**Image Plates,** brass stand with hook, to connect to prime conductor, for pith figures, illustrating electrical attraction and repulsion (fig. 2223)	0 6 6	0 12 6
2224	**Image Plates,** with insulated glass support for the upper plate, connection being made from the prime conductor, the figures are removed from the attractive influence of the cylinder (fig. 2224)	0 15 0	0 18 6
2225	**Dancing Figures,** made of elder pith, plain 1s., jointed	0 2 0	0 3 0
2226	**Pith Ball Stand,** another illustration of electrical attraction and repulsion		0 5 0
2227	Ditto, with ball and wire (fig. 2227)		0 8 0
2228	**Pith Balls** . . . . per doz.	0 1 0	0 1 6
2229	**Grotesque Carved Head,** with Hair, for illustrating the principle that bodies similarly electrified repel each other (fig. 2229)	0 4 0	0 6 6
2230	**Electrical Figure,** carved of cork, representing a swan, which, placed on the surface of a vessel of electrified water, will be attracted to any part by presenting the finger to it (fig. 2230)		0 4 6
2231	Ditto ditto, representing Neptune, seahorses, &c. (fig. 2231) . . . . from		0 7 6
2232	**Electrical Spider,** by electrifying which, and presenting a ball, will be attracted, but repelled by a point . .		0 1 0
2233	**Coloured Glass and Paper Plumes,** to exhibit the repulsive action of similarly electrified bodies	0 2 6	0 5 6
2234	**Electrical Flask,** with brass cap and valve for exhaustion, to imitate the aurora borealis (fig. 2234) . . .	0 7 6	0 12 6
2235	**Glass Globe,** with stop-cock, sliding wire, with forceps, &c., for showing the passage of electric light through a partial vacuum or different gases (fig. 2235) . . .	2 2 0	2 12 6
2236	**Luminous Conductor,** or apparatus to exhibit the effect of a falling star, with valve for exhaustion (fig. 2236)		1 1 0
2237	Ditto with **Stop Cock,** large size	2 2 0	3 3 0

2238 **Bucket and Syphon** to suspend from the prime conductor; this experiment shows that water, which previous to being electrified only fell in drops, when electrified runs in a stream, and in a dark room is luminous 3s. 6d., 5s. 6d.

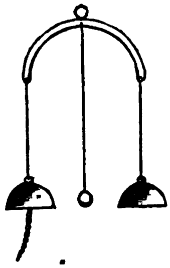


FIG. 2245.

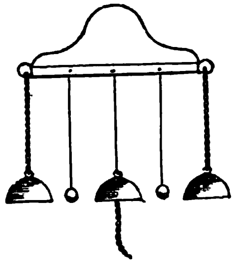


FIG. 2244.

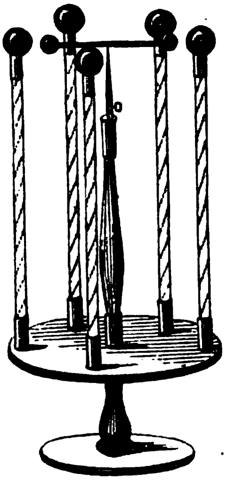


FIG. 2240.

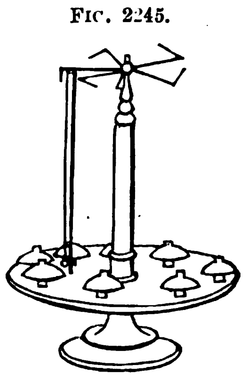


FIG. 2243.

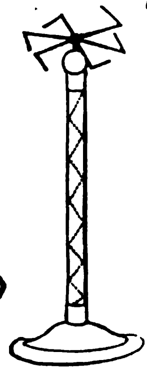


FIG. 2242.

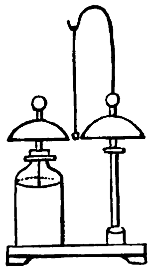


FIG. 2246.

2239 **Hand Spiral**, consisting of two glass tubes with brass caps, the inside one covered in a spiral form, with spangles of tin foil, showing when presented to an excited conductor, a spiral stream of electrical light (fig. 2239) 3s., 4s., 5s. 6d.

2240 **Set of Five Spirals**, Best, with coloured tubes (fig. 2240), on mahogany pedestal, with insulated revolving balls in the centre which, by their motion, produce a splendid succession of spiral lines of light £2 2 0

2241 **Luminous Chain Experiment** (fig. 2241) £0 15 0

2242 **Revolving Spiral**, on stand. The electric fly or whirl revolves by the dispersion of electricity from the points, presenting a very beautiful appearance in a dark room (fig. 2242) £0 16 6

FIG. 2247.

FIG 2247*.

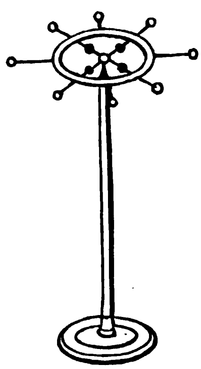


FIG. 2249.

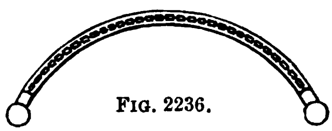


FIG. 2236.

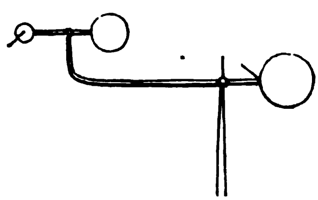


FIG. 2250.

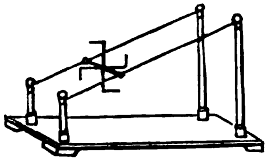


FIG. 2253.

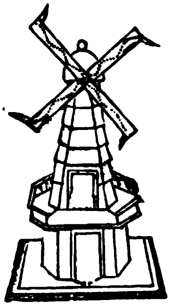


FIG. 2251.

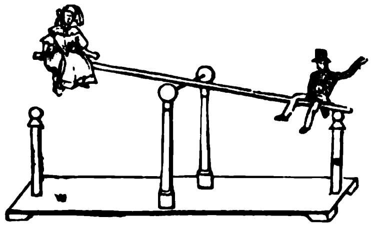


FIG. 2252.

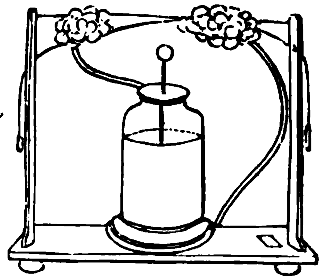


FIG. 2254.

No.	Article	Each. £	s.	d.	Each. £	s.	d.
2243	**Gamut of Bells.** This experiment consists of eight bells arranged on a stand, with an electrical fly or whirl carrying a clapper, which, in revolving, strikes each of the bells (fig. 2243)				2	2	0
2244	**Set of two Electrical Bells.** The simplest form of the experiment, one bell communicating with the prime conductor, the other with the ground, and made to ring by the alternate blows of a brass ball suspended between them by a silk cord (fig. 2244) . . .				0	3	6
2245	**Set of Three Bells,** on brass rod, to suspend from the conductor. The action of these is the same as the preceding (fig. 2245)				0	8	6
2246	**French Arrangement** for illustrating the chiming of bells, by electrical action, one bell being connected with the inner, and the other with the outer coating of a Leyden jar (fig. 2246)				1	1	0
2247	**Electrical Fly or Wheel,** for producing motion by the dispersion of electricity from points (figs. 2247 & 2247*)	0	3	6	0	7	6
2248	Three ditto on one stand				0	8	6
2249	**Franklin's Electrical Self-moving Wheel,** with glass spokes, terminating with brass balls. Placing the wheel between a charged battery and a conductor to the earth, the wheel is caused to rotate by attraction and repulsion (fig. 2249)	2	2	0			
2250	**Electrical Orrery or Planitarium,** representing the motions of the sun, earth, and moon (fig. 2250) .	0	8	6			

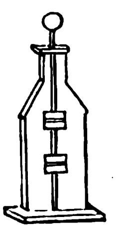


FIG. 2256.

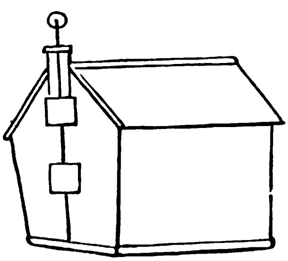


FIG. 2258.


FIG. 2257.


FIG. 2256*.

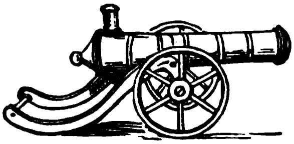


FIG. 2262.

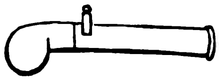


FIG. 2263.

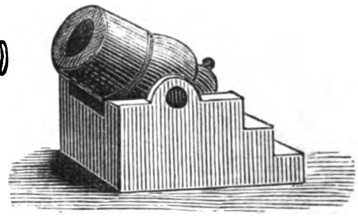


FIG. 2267.

No.	Article	Each. £ s. d.	Each. £ s. d.
2251	**Electrical Mill**, showing rotation produced by electricity given off from the points of the vane (fig. 2251)		1 1 0
2252	**Electrical See-Saw**, illustrating electrical attraction and repulsion (fig. 2252)		0 15 0
2253	**Electrical Inclined Plane**, the fly revolving by the dispersion of electricity from the points, and ascending the incline (fig. 2253)		1 1 0
2254	**Apparatus** for explaining the theory of Thunder Clouds (fig. 2254)		1 5 0
2255	**Harris's Thunder Cloud Apparatus**, constructed of a light metal needle, balanced to turn very freely upon a vertical point connected with one coating of a large Leyden jar, or Electric Battery. One end of the needle is covered with light cotton wool, to represent a cloud, which can be arranged to approach either figs. 2256, or 2258, and the discharge takes place; a very interesting experiment		1 0 0
2256	**Thunder House** (Dr. Priestley's), or Obelisk for showing the use of lightning conductors in protecting buildings (figs. 2256 and 2256*)	0 12 6	0 15 0
2257	**Fire House**, for illustrating the same fact (fig. 2257) .		1 4 0
2258	**Powder House**, for showing the necessity of a continuous metallic lightning conductor, which, in this experiment, is broken in the centre of a cup containing gunpowder. This is ignited and explodes by an electrical discharge, blowing down the house (fig. 2258)	1 10 0	2 0 0
2259	**Sturgeon's Apparatus** for igniting Gunpowder, Alcohol, Æther, &c., by electricity (fig. 2259)		0 12 6
2260	**Apparatus** for the ignition of Phosphorus, consisting of two brass cups, insulated upon glass supports, for holding small pieces of phosphorus; between these is a stand for a small lamp or candle; the passage of electricity between the cups will carry the flame towards the phosphorus, and ignite it (fig. 2260) . .		0 14 0

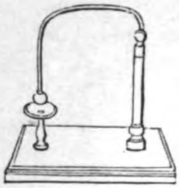


FIG. 2259.

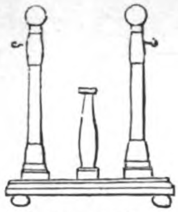


FIG. 2260.

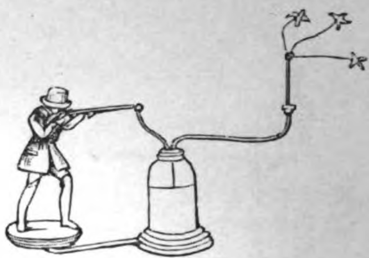


FIG. 2261.

No.	Description	Each. £ s. d.	Each. £ s. d.
2261	**Electrical Sportsman.** This popular experiment consists of a Leyden jar, and a figure carved to represent a Sportsman shooting; two wires are inserted in the jar, at the end of one some pith birds, the other is brought near the point of the gun. A chain from the prime conductor is connected with the wire communicating with the base of the jar, and as soon as the machine is put in action the birds rise but fall, as if shot, immediately the jar is discharged (fig. 2261)	1 6 0	1 15 6
2262	**Electrical Cannons,** for firing a mixture of Hydrogen gas and Atmospheric Air by an electric spark (fig. 2262). See also No. 2110°	0 16 0	1 1 0
2263	**Electrical Pistol,** for the same experiment (fig. 2263).	0 7 6	0 10 6
2264	**Apparatus and Material** for charging ditto with Gas.	0 4 6	0 11 0
2265	**Electrical Powder Cannon,** for firing Gunpowder by charge of a Leyden Jar, similar to one figured in "Galvanic Section" . . . . . . from		0 10 6
2266	**Electric Bomb, or Mortar,** of hard wood or ivory, having two wires so arranged that when a large Leyden jar or Electric Battery is discharged through them, a sudden expansion of the air in the Mortar is caused, and will expel with considerable force a small ball of cork placed nearly air-tight in the barrel of the bomb. If a drop of Æther be placed in the chamber the result is more violent (fig. 2267)	12s. 6d.,	0 15 0
2267	**Eudiometrical Tube,** for exploding detonating mixtures of gas by the passage of an electric current or spark passed between two platinum wires. See also "Eudiometer," page 339		0 10 6

2267° **Volta's Condensing Electroscope** (fig. 2172), invented by Volta, is a modification of Singer's and Bennett's Gold Leaf Electroscopes. The metal wire to which the gold leaves are affixed, terminates in a flat metal plate, as seen in the wood cut, and the instrument is supplied with a second metal plate of similar size, fitted with an insulating glass handle, the one being termed the collecting, and the other the condensing plate, both plates are coated with insulating shellac varnish. Particulars of the method of using Volta's Electroscopes will be found in Gannot's Physics. price £1 10 0

Volta's Electroscope is sometimes mounted with Light Straws or small Pith Balls instead of Gold leaves.

No.	Description	£ s. d.
2267A	**Insulating Table Stand** (fig. A), for supporting and insulating Electrical apparatus, 14-inches adjustment	0 7 6
2267B	Ditto ditto Best make with heavy base	0 10 6

FIG. C.

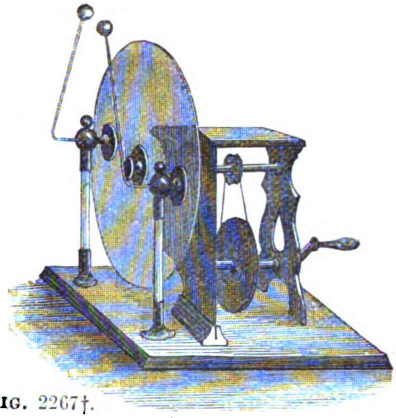


FIG. 2267†.

FIG. A.

2267† **Piche's Electro-Static Induction Machine,** is a modified arrangement of Holtz's machine. It is composed of a circular plate of *Vulcanite,* in front of which are placed two collecting forks in metallic connection with two brass rods mounted on jointed insulated supports; these rods are so contrived that they can be moved in any direction, or the terminal balls brought close together. On one side and at a small distance behind the revolving plate is placed a flat oblong plate also of *Vulcanite,* termed the *Induction Plate.*

To put this machine in action the Induction Plate is withdrawn from its groove on the base of the stand, and excited by rubbing it briskly with a cat skin or a woollen cloth (Flannel), and quickly replaced in the groove, then upon rotating the circular Vulcanite plate by the handle and multiplying wheels, it will be found that one fork or comb will collect Positive, and the other Negative Electricity.

Price of Piche's Machine as fig. 2267†, with 18-inch Vulcanite Plate £12 12 0

	Each. £	s.	d.
2267C **Kinnersley's Electrical Thermometer,** a modification of Harris's instrument for exhibiting the transient expansion of air by the passage of Electricity through it (fig. C.)	1	0	0
2267D **Faraday's Butterfly Net,** with Glass handle and insulating stand (fig. G.)	0	8	6
2267E **Wire Gauze Cylinder** (fig. H.), on insulating stand, with hollow ball for exhibiting that electricity, is distributed only upon the surface of conductors similar to Biot's Experiment. No. 2189, page 376 . . . . price	0	12	6
2267F **Electrical Conductors,** a set of three forms, consisting of a Sphere, Cone, and Cylinder of wood, covered with Tin Foil, and mounted upon insulating stands (figs. D., E., and F.) . . . . price	1	6	0
2267G The three Conductors can be supplied with one Insulating Stand .	0	18	6

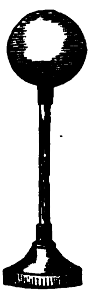


FIG. D.

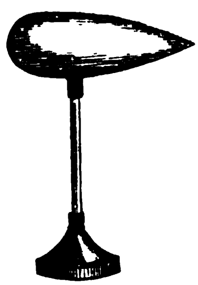


FIG. E.

FIG. F.

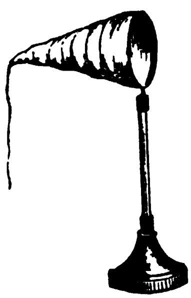


FIG. G.

FIG. H.

Most of the Electrical Apparatus catalogued in this section will be found fully described in *Noad's Lectures on Electricity, Noad's Student's Text Book, Ganot's Physics,* translated by Atkinson, and Tyndall's *Lessons in Electricity.*

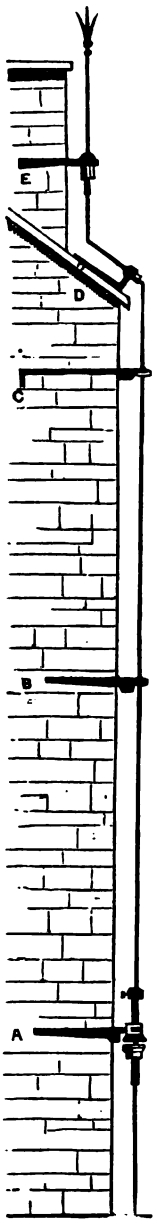


FIG. 2290.

No.	Description	Each. £ s. d.	Each. £ s. d.
2268	**Cylinders,** of Shellac, Sealing Wax, Sulphur or Vulcanite for illustrating Resinous excitation	0 2 6	0 6 6
2268°	**Apparatus for producing Lichtenburg's Figures,** consisting of a flat Resin cake, a bottle of Powdered Red Lead, mixed with Powdered Sulphur, a square of Muslin Gauze; in a box .		0 12 6
2269	**Cylindrical Glass Tubes,** for exhibiting vitreous Electrical excitation . . .	0 1 6	0 3 0
2270	**Fur Rubber, or prepared Cat's Skin,** for Electrical excitation	0 10 6	0 18 0
2271	**Fox Brush** for ditto ditto		0 2 6
2272	**Cylinders, Electrical.** . 3s. 6d., 4s. 6d.,	0 6 6	0 12 6
2273	**Circular Glass Plates,** for Electrical Machines, cut and polished :—		

Diameter	9-in.	12-in.	15-in.	18-in.	24-in.
Price .	6s.	12s.	21s.	30s.	66s.

2274 **Circular Ebonite Plates** :—for Electrical Machines.

Diameter	12-in.	15-in.	18-in.	24-in	30-in.	36-in.
Price .	16s.	22s.	30s.	46s.	66s.	86s.

No.	Description	Each. £ s. d.	Each. £ s. d.
2275	**Conducters** for Electrical Machines, black japanned Tin or Zinc 3s. 6d.	0 5 6	0 6 6
2276	Ditto, Brass . . . . . from		0 7 6
2277	**Glass Jars,** for coating, ½-pts. 1s., pts. 1s. 6d., qts. 2s., 3 pts.		0 3 0
2278	**Glass Handles** 1s. 6d.,	0 2 0	0 3 6
2279	**Gutta Percha Handles**	0 1 6	0 2 6
2279*	**Glass Legs or Supports** . 1s. 6d.,	0 2 0	0 2 6
2280	**Glass Rod,** for Electrical apparatus, per lb.		0 2 6
2281	**Brass Balls** . . . 9d., 1s., 1s. 6d.	0 2 0	0 2 6
2282	Ditto, with Collar and Wire, for mounting up Leyden Jars . . . . 2s.	0 2 6	0 3 6
2283*	**Amalgam,** per box		0 1 0
2284	**Brass Chain,** per yard		0 0 6
2285	**Flexible Conducting Wire,** per yard, very convenient		0 0 6
2286	**Strips of Gilt and Silvered Leather,** to illuminate by the electric spark, per yard		0 2 0
2287	**Balls of Ivory, Bone, Boxwood, and Ebony**	0 1 0	0 2 0
2288	**Brass Clamps,** for fixing apparatus to table	0 3 0	0 4 6
2289	Strong Iron Clamps for Ditto . .		0 3 6

2290 **Patent Copper Wire Rope solid Copper Rod, or Flat Copper Band, Lightning Conductors,** with the point and all staple, &c., complete for fixing (fig. 2290). For full description and prices, see pages 104 and 105.

ESTIMATES GIVEN FOR FIXING OR REPAIRING LIGHTNING CONDUCTORS.

VOLTAIC ELECTRICITY.

In the year 1790, Galvani, Professor of Anatomy at Bologna, first made the very curious discoveries in connection with the muscular contraction of a frog's legs by electrical action, to which we owe the origin of the most practically useful of all branches of electrical science, and in 1800 Alexander Volta, Professor of Physics, of Pavia, described in the *Philosophical Transactions* the first galvanic or voltaic instrument, *viz.*, Volta's Pile; hence it is that this remarkable form or condition of electricity is now universally known by the terms Galvanism or Voltaism. Its study has for the past eighty-five years intently occupied the minds of scientific men of all nations with a view to its utilisation. The limits to which we are compelled to confine ourselves preclude our entering minutely into the chronological history of their various ingenious and brilliant experiments, or the valuable discoveries resulting from their labours, and therefore can only refer to the Electrotype in conjunction with the Electro Gilding and Plating process, and the Electric Telegraph, as two of the greatest marvels of the present century.

We quote the following paragraph from Mr. Noad* as a concise account of the origin of Electro-Metallurgy, and will refer again to the Telegraph in another section: "In our historical account of the Sulphate of Copper Battery of Daniell, it was stated, that on completing the circuit the electrical current passes freely through the metallic solution; that no hydrogen makes its appearance on the conducting plate, but that a beautiful pink coating of pure copper is deposited on it, and thus perpetually renews its surface. In the discovery of this battery, then we find the origin of electro-metallurgy: for it appears that in his earlier experiments it was noticed by Mr. Daniell, that on removing a piece of the reduced copper from a platinum electrode, scratches on the latter were copied with accuracy on the copper, and Mr. De la Rue later, in a paper in the *Phil. Mag.*,† detailing some experiments with a voltaic battery of ordinary construction, charged with sulphate of copper, made the observation that 'the copper-plate is covered with a coating of metallic copper, which is continually being deposited;' and he proceeds to remark, 'so perfect is the sheet of copper thus formed, that on being stripped off it has the polish and even a counterpart of every scratch of the plate on which it is deposited.' On reading this passage at the present time, when the art of electro-metallurgy is so extensively practised, we can hardly resist a feeling of surprise that the application of the *facts* discovered by Daniell and De la Rue did not occur to either of these gentlemen. They were, however, too intent on the battery itself, to attend to any collateral circumstances; and it was left for Jacobi, in Russia, and Spencer, in this country, to do so. The process of the former distinguished philosopher was called 'Galvano-plastic;' that of Mr. Spencer, 'Electrography.' And though it is quite certain that the discovery was made by each independent of the other, the priority must be given to Jacobi, who states in the preface of his '*Galvanoplastik*,'‡ that it was in the month of February, 1837, while prosecuting his galvanic investigations, that he discovered a striking phenomenon which presented itself in his experiments, and furnished him with perfectly novel views; and Mr. Spencer in his pamphlet§ informs us, that his first results were obtained in 1838." ||In the London *Mechanic's Magazine*, published June 8th, 1839, will be found a letter from Mr. C. J. Jordan, a printer, dated May 22nd, 1839, "Engraving by Galvanism," giving details of his method of procuring Electrotypes and offering hints for its application which have since been acted upon with considerable success. *Mr. Jordan's letter was no doubt the first published* description of the art in this country.

* Noad's *Lectures on Electricity*. † Vol. ix. p. 484. ‡ Translated from the German edition, by Wm. Sturgeon. § Griffin's *Scientific Miscellany*, No. iv., p. 33. || James Napier's *Manual of Electro-Metallurgy*.

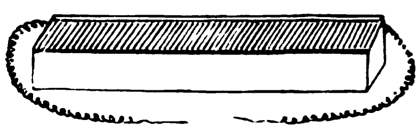
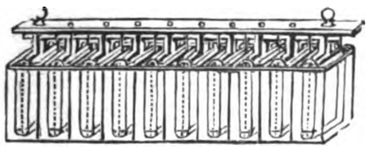
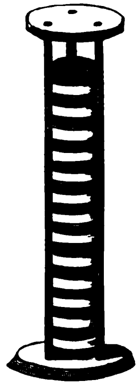


FIG. 2297.





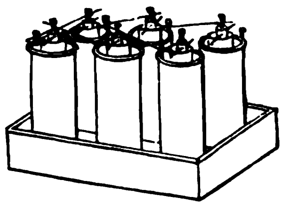


FIG. 2298. FIG. 2291. FIG. 2304.

VOLTAIC OR GALVANIC APPARATUS.

		Each. £ s. d.	Each. £ s. d.
2291	**Volta's Pile of 50 pair of Zinc and Copper Plates,** soldered together, on a mahogany stand (fig. 2291) .	0 16 0	1 8 0
2292	**Zinc and Copper Plates,** circular, soldered together per doz.		0 5 0
2293	**Pairs of Silver and Zinc Wires,** soldered together, for *Volta's Couronne de tasse* . . . . . per doz.		0 8 0
2294	**Pair of Circular Zinc and Copper Plates,** with Glass handles, for showing the production of electricity by contact		0 12 6
2295	**Zinc and Copper Sieves,** with Glass Handle, to illustrate the Electric Action produced by sifting metal filings on a delicate Electrometer . . . . . per pair		0 14 0
2296	**Cruikshank's Batteries,** Zinc and Copper, in mahogany troughs, for Medical purposes, 25 pairs of plates, 2½-inch		1 10 0
2297	Ditto 50 pairs of plates, 2½-inch (fig. 2297)		2 2 0
2298	**Wollaston's or Babington's Battery** of ten pairs of 4-inch plates, Zinc and Copper, with divided trough (fig. 2298)		2 2 0

Cruikshank's, Wollaston's, or Sturgeon's Batteries, are charged with dilute Sulphuric acid in the proportion one part, by measure, strong acid, to fourteen parts Water; or, if very strong action be required for a short time the quantity of the acid may be increased. Dr. Fyfe found the use of a solution of Sulphate of Copper in these batteries increased their action.

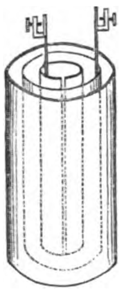


FIG. 2299.

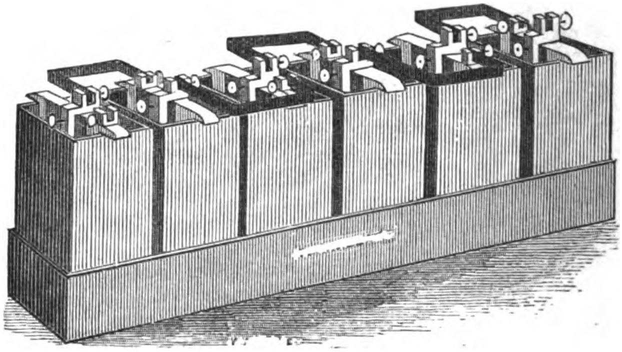


FIG. 2309.

		Each. £ s. d.	Each. £ s. d.
2299	**Sturgeon's Cylindrical Battery,** of Copper and Zinc, (fig. 2299) a simple and cheap but very useful battery, for elementary class instruction; for feeble but continued action solutions of either common Salt or Hydrochlorate of Ammonia, are to be used, and dilute Sulphuric Acid, one part strong acid to ten parts water for stronger action	0 7 6	0 10 6
2300	**Calorimotor, Wollaston's,** 1 pair of 6-inch zinc and double copper plates, in a trough (fig. 2300) . .		0 10 6
2301	**Calorimotor, Hare's,** large size	10 0 0	20 0 0
2302	**Daniell's Sustaining Battery,** consisting of a cylinder of Zinc and Copper, separated from each other by a porous earthenware tube, and excited by a solution of Salt and Water, or diluted Sulphuric acid, one part acid to ten parts Water, in contact with the zinc, and a Saturated solution of Sulphate of Copper in the other cell. Price for single cells 5s. 6d.,	0 8 0	0 11 0
2303	**Daniell's Battery,** containing six ½-lb. cells of the above, in mahogany tray		1 12 6
2304	Ditto ditto containing twelve 1-lb. cells, in mahogany tray (fig. 2304)		4 4 0

Daniell's Battery is the best arrangement for use where a steady and very uniform current is desired for any length of time; much used for Electro-plating, Gilding, and Electrotyping purposes.

2305	**Mullin's Battery,** a modification of Daniell's Cell consists of cylinders of Zinc and Copper, separated from each other by Bladder or Porous Earthenware; excited by a solution of common Salt and Water in contact with the Zinc and a solution of Sulphate of Copper in the other cell. Single cells . . 5s.,	0 7 0	0 15 0

Larger sizes of Daniell's or Mullin's Batteries in single cells or series, to order.

FIG. 2306.

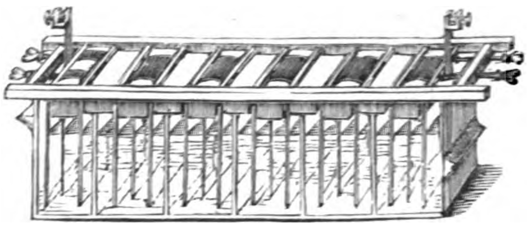


FIG. 2311*.

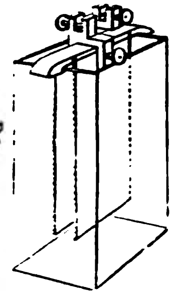


FIG. 2307.

2306 **Smee's Batteries,** in round Stoneware Pots, so arranged with brass clamps that the zincs can be easily removed for cleaning and amalgamating, and replaced (fig. 2306)—
½-pt. 5s. 6d. 1-pt. 8s. 6d. 2-pts. 11s. 6d. 3-pts. 14s.

Smee's Batteries are constructed with one plate of thin Platinized Silver, and two plates of Amalgamated Zinc. For charging Smee's Batteries one part, by measure of strong Sulphuric Acid, to 10 or 12 parts of Water, will be found sufficient for slow and gentle action; for more powerful results, 1 part acid to 8 of water should be used. It should be noted that in making dilute sulphuric acid the strong acid should be *poured into* the water slowly and gradually.

The superiority and convenience of this Battery over all others consists in the little trouble required to put it in action, and the great power obtained. They are not obnoxious or disagreeable during their action, hydrogen only being evolved. One Battery with a piece of platinized silver two inches square, immersed in a tumbler of dilute acid, in connection with an electro-magnet, will support three hundred-weight.

		Each £ s. d.	Each. £ s. d.
2307	**Smee's Batteries,** in flat Glass Cells (fig. 2307) . . .	0 12 6	0 15 6
2308	**Set of Six Half-pint Smee's Batteries,** in round pots, and a mahogany tray		1 18 6

This set is so arranged, that it can be used for quantity or intensity effects, will show all the leading facts connected with galvanism, decomposing water, deflagrating metals, &c., &c., and is well adapted for the instruction of a small class. Smee's Batteries arranged in an intensity series, and excited with *exceedingly weak acid* answer well for ringing signal bells or short telegraph lines, care being taken to keep the zinc plates well amalgamated.

2309	**Set of Six one-pint Smee's Batteries,** in flat Stoneware cells and mahogany tray (fig. 2309)		3 3 0
2310	**Set of six two-pint ditto,** in ditto		4 4 0
2311	**Set of Six one-pint ditto,** in flat cells and mahogany tray, with counterpoise weights, or ratchet wheel, for suspending the battery when not in use	3 15 0	5 5 0
2311°	**Smee's Batteries,** Intensity Series . . . . . See also Section Electric Telegraph.		5 5 0

Grove's Batteries, the elements consist of a double plate of amalgamated Zinc, and a single plate of Platinum; a porous cell separates the metals; the former being excited by Sulphuric acid and Water (1 part strong sulphuric acid to 8 parts of water), the latter by concentrated Nitric acid. This is the most powerful of all voltaic arrangements, and is the best adapted for brilliant and showy experiments in public institutions, or where a powerful current is required. The action is very uniform for some considerable period. A De la Rive's Battery is a modification of Grove's, the Nitric Acid being on the exterior in a large glass bottle. A porous cell or tube containing the Zinc and dilute Sulphuric Acid is inserted into the bottle; this is removed out of the glass bottle containing the Nitric Acid, and replaced by a Glass stopper when the Battery is not in use; by this arrangement a large quantity of Acid can be retained ready for use without the escape of acid fumes.

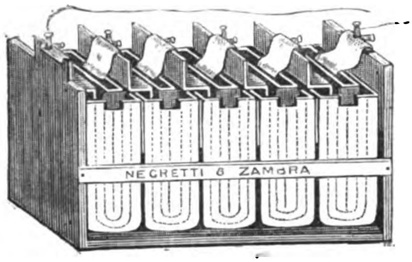


FIG. 2314.

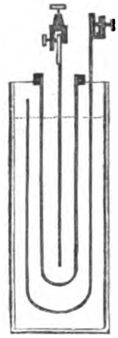


FIG. 2312.

		Each. £ s. d.	Each. £ s. d.
2312	**Grove's Battery,** single cell (fig. 2312)		0 10 0
2313	**Set of Four Grove's Batteries,** with suitable metallic connections, porous cells, and earthenware troughs, in mahogany tray		2 10 0
2314	**Set of Five Grove's Batteries,** in tray (fig. 2314) .		3 3 0
2315	**Set of Eight** ditto, in mahogany tray .		5 5 0
2316	**Set of Ten** ditto, in ditto		6 6 0
2317	**Grove's Gas Battery,** in which the active elements are Hydrogen and Oxygen gases; set of six gas batteries mounted on a stand		6 10 0
2318	**Water Battery, Crosse's,** a Voltaic Combination of high intensity		

Fitted up to order with any number of pairs of metallic elements, placed in glass or porcelain cells, from 200 to 2000. The apparatus is constructed with due regard to insulation, and, by means of binding-screws, the action of any number in the series may be examined with great convenience, and any cells removed without disturbing others.

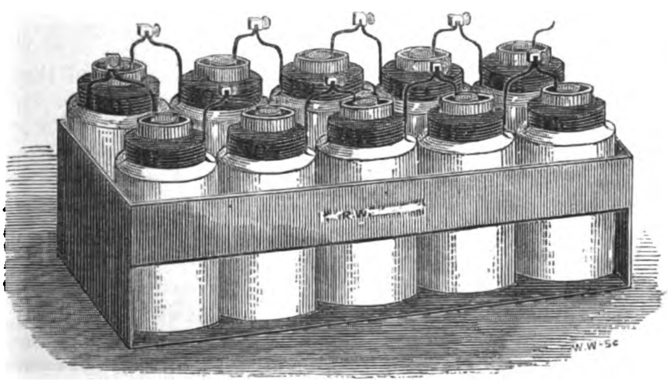


FIG. 2320.

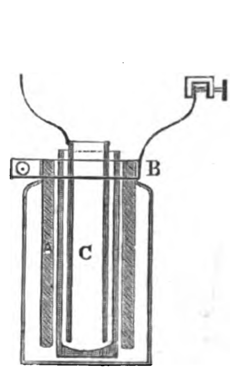


FIG 2319.

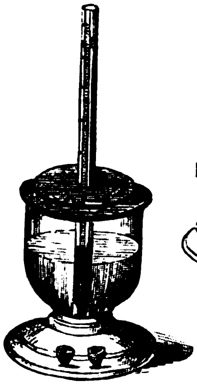


FIG. 2331.

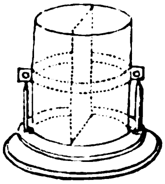


FIG. 2336.

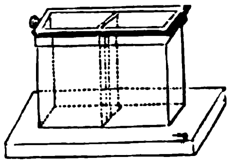


FIG. 2336*.

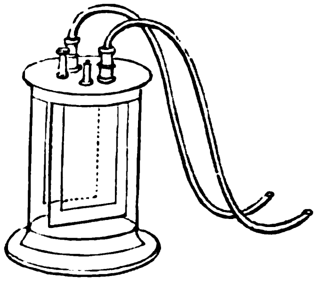


FIG. 2335.

No.		Each. £ s. d.	Each. £ s. d.
2319	**Bunsen's Carbon Battery,** single cell (fig. 2319)		0 10 6
2320	**Bunsen's Batteries,** a series of ten, arranged in a stout wood tray (fig. 2320)		5 5 0

The Carbon Batteries are excited by the same acids as Grove's arrangement (strong nitric acid and dilute sulphuric acid, 1 part strong acid to 7 or 8 of water), and will be found next to it in intensity and energy, at a much lower original cost.

No.		Each. £ s. d.	Each. £ s. d.
2321	**Callan's Cast Iron or Maynooth Batteries** . . 5s.	0 7 6	0 10 6
2322	**Sets of Five and Ten Cast Iron Batteries,** full size, in a Stout wood tray	2 15 0	5 5 0

The Maynooth Battery is composed of a Cast Iron Cell, a rectangular Porous Pot, and a stout plate of Amalgamated Zinc. The porous cell is charged with Dilute Sulphuric Acid, one part strong acid to eight parts Water, and the Iron Cell with strong Nitric and Sulphuric Acids, with a Saturated Solution of Nitrate of Potash in equal parts. This also is a very powerful form of battery, adapted to exhibit all galvanic phenomena with great brilliancy, and suited for rough Manufacturing or Mining purposes. Professor Faraday found the efficiency and steady working of Callan's Battery much improved by using equal parts of strong Nitric Acid and strong Sulphuric Acid in the *Iron Cell*, omitting the Solution of Nitrate of Potash.

No.		Each. £ s. d.	Each. £ s. d.
2323	**A Set of 25 Callan's or Maynooth Batteries,** sufficient for producing a very effective **Electric Light** for private exhibition. In two strong trays		9 9 0

2324 **Walker's Battery** is similar to Smee's arrangement; but in place of the Platinized Silver (or Electro Negative Plate) slabs of Gas Graphite or Platinized Graphite are used, the other element being Amalgamated Zinc, the battery, like Smee's, being charged with Dilute Sulphuric Acid. This battery is economical and simple in use, has considerable Electro Motive Force, and has been found very serviceable for Railway Telegraph work. Price for Walker's Battery, per cell, about as Smee's Batteries.

See No. 2238. The Leclanché Cell has now superseded this battery.

2324* **Dr. Leeson's Battery** is formed of a plate of Copper in a Porous Cell, surrounded by a plate of zinc in a stoneware jar. The Porous Cell is charged with a Solution of Bichromate of Potash, one part of Bichromate to ten parts of Water, the outer jar being charged with Dilute Sulphuric Acid. Price of Dr. Leeson's Batteries same as Daniell's. See No. 2234.

BICHROMATE BOTTLE BATTERY.

One of the most elegant and convenient forms of galvanic battery yet introduced is that shown in our engraving (fig. 2256); it is a modification of Dr. Leeson's Bichromate Battery; the elements are two plates of Graphite or Gas Carbon, and a stout plate of Zinc. The exciting fluid is a saturated solution of Bichromate of Potass (about 2 ounces of bichromate potass to 1 pint of water), with one part by measure of strong Sulphuric Acid to every twelve parts of bichromate solution (nearly two fluid ounces of acid to an imperial pint, or twenty ounces). This acid should be added to the bichromate slowly: when the solution is cold, it is ready for use It will be seen from the drawing that the glass bottle-shaped cell has a long neck. This is contrived for the purpose of withdrawing the zinc element from the exciting fluid when the battery is not in use, and thus stopping all action or waste. This zinc plate is placed between the two carbon plates, and is only half their length, by a stout wire rod attached to it; the zinc can be withdrawn from or immersed in the exciting fluid very conveniently, and rapidly set in action any apparatus connected with it, such as an induction coil, a signal bell, or small telegraphic instrument. Its simplicity, combined with the absence of any fumes or smell render the Bichromate Battery most useful for short action.

The Bichromate Batteries may be combined either for quantity or intensity effects.

2325 **Bichromate Bottle Batteries** (fig. 2325)—

	1-pt.	2-pts.	4-pts.
Price, each . .	15s.	£1 1s.	£2 2s.

The Zinc Plates of Smee's, Grove's, Callan's, and Bunsen's Batteries should be examined now and then, and re-amalgamated to prevent local action, *and it is advisable to thoroughly wash with plenty of clean water all batteries before putting away, after use.*

2326 **The Leclanché Battery.** The elements in this battery are a cylinder of Carbon, inserted into a round porous tube, closely surrounded by a mixture of small fragments of very pure Peroxide of Manganese and Coke. The top of the mixture in the porous pot is covered with wax. The porous cell and its contents are placed in a glass bottle, as seen in fig. 2326, with a rod of Zinc (the Electro Positive element); and this glass cell is to be about half-filled with a solution of Chloro-hydrate of Ammonia (the Sal Ammoniac of commerce).

The Electromotive force of the Leclanché Cell is stated by Ganot to be $\frac{8}{10}$ that of a Daniell's Cell, and its resistance about $1\frac{1}{4}$ of a British Association Unit. For durability and cleanliness the Leclanché Cells are unequalled, requiring but a minimum of attention, whilst on the other hand, for cost of working they are the cheapest form of battery that is made, no local action taking place when not in actual use. They may therefore be specially recommended for all classes of intermittent work: the consumption of material being in direct proportion to the amount of work performed. For train signalling apparatus, and for ringing bells, these batteries have been found to answer well for long periods of time. The inventor states that the Electromotive Force is 75 per cent. greater than the Daniell Battery, whilst its resistance is 90 per cent. less: and gives the following instructions for charging, which should be carefully attended to.

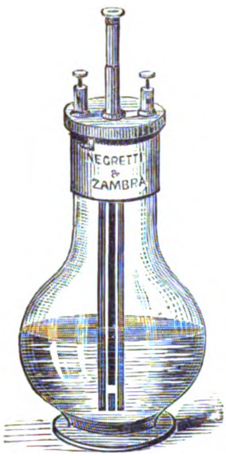


FIG. 2325.

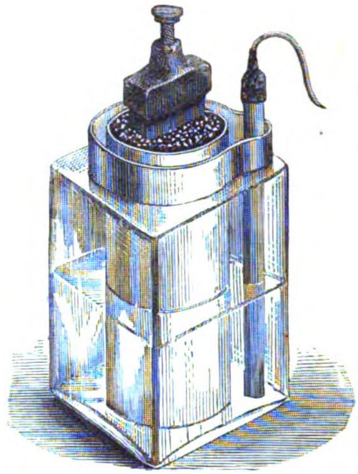


FIG. 2326.

Fill the glass cell about ½ an inch high with powdered Sal Ammoniac; put the porous cell in its place, and *half fill* the glass cell with water pouring a *little* water into the porous cell also, through the holes in the top. The solution of Sal Ammoniac should always be strong, an excess of salt being kept in the cell.

The battery will remain in working order so long as the solution is clear, and in contact with the zinc. When the solution becomes turbid or milky, add Sal Ammoniac, and in a few hours the battery will be as powerful as ever. It may be placed aside for months without deteriorating. Special care should be taken that the porous cell never stands more than half its height in the liquid.

	Each. £ s. d.	Each. £ s. d.
Price for the Leclanché Battery Cells (fig. 2326) .		
Each . No. 1, 8s.; No. 2, 5s. 6d.; No. 3,	4s. 6d.	
Extra Zincs for above . . . . each . 1s.	0 1 3	0 1 6
Chloro-hydrate of Ammonia in Powder . per lb.		0 1 6

2326*	**Insulated Stand,** for exhibiting the combustion of Carbon, fusion of wire, &c., with the Galvanic Battery	1 5 0
2327	**Insulated Stand,** with Henly's Universal Discharger and Press, two pairs of forceps, &c., applicable for both Voltaic and Frictional Electricity (see *ante*, page 376, fig. 2191)	2 10 0

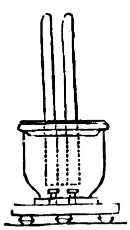


FIG. 2335.

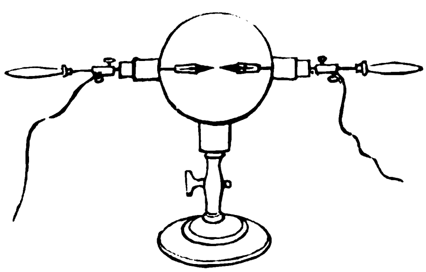


FIG. 2328.

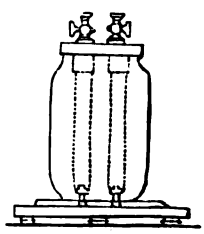


FIG. 2335*.

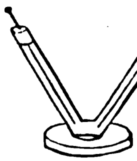


FIG. 2337.

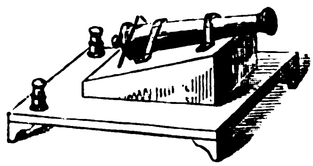


FIG. 2342.

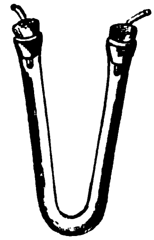


FIG. 2337*.

No.	Article	Each. £ s. d.	Each. £ s. d.
2328	**Glass Globe,** with Stopcock, brass caps, sliding forceps and balls, for showing Electrical Light *in vacuo,* and decomposing gases by the ignition of Carbon points with the galvanic battery (fig. 2328), see also (fig. 2235)		3 3 0
2328*	**Lamp, Electric,** with self-regulating apparatus for the carbon points		12 12 0
2329	Ditto ditto **Duboscq's** arrangement . . .		13 0 0
2330	**Decomposition Apparatus,** with **Single Tube,** for collecting the gases combined . . . 7s. 6d.,,	0 15 0	1 1 0
2331	**Decomposition Apparatus,** with single **graduated tube** (fig. 2331)		1 5 0
2332	**Apparatus for Decomposing Water** (Volta-meter), with **double tubes** for collecting the Oxygen and Hydrogen gases separate, small size	0 10 6	0 16 0
2333	**Decomposition Apparatus, Double Tubes,** larger, suitable for lecture tables or private experiments (figs. 2333 and 2333°) . . . . . . from	1 1 0	1 10 0
2334	**Decomposition Apparatus,** with **Double Tubes graduated** into 10ths and 100ths of a cubic inch .	1 10 0	2 2 0
2335	**Volta-Meter,** with large Platinum Electrodes, divided by a porous diaphragm, for experiments with large and very powerful batteries (fig. 2335)		3 3 0
2336	**Faraday's Apparatus,** for Electro Chemical Decompositions, consisting of a glass trough divided by a diaphragm (figs. 2336, 2336°)	0 14 6	1 1 0
2337	**V Tube** for the decomposition of Neutral Salts (figs. 2337, 2337*)	0 5 0	0 10 6
2338	**Pieces of Platinum and Silver Wire** soldered together alternately; a strong voltaic current passed through, causes the platinum to become red hot without heating the silver		0 12 6
2339	**Apparatus** to exhibit the increase of temperature produced by the passage of an electric current through a fine platinum wire enclosed in a glass tube, which prevents radiation, and a much greater length of wire is heated than if it be exposed without the tube .		3 0 0
2340	Arranged for experiments with the tube exhausted of air, or charged with different gases (fig. 2236) . .		3 3 0
2341	**Electro-Thermometer** (Harris's), for measuring the Calorific effects of electricity		1 18 0

No.	Article	Each. £ s. d.	Each. £ s. d.
2342	**Model Cannon or Bomb,** mounted on mahogany stand, with binding screws, &c., for firing gunpowder by Galvanic Battery (fig. 2342)		1 1 0
2343	**Model Apparatus for Submarine Explosions.** For explaining and exhibiting the method of firing gunpowder or other explosive compounds (Torpedoes) beneath the surface of water, or at long distances, either for engineering purposes, or for Naval and Military warfare	0 15 6	2 2 0
2344	**Rectangular Battery Cells,** of hard glazed Porcelain, with porous jars, 6-in. high, 6½-in. wide, 2-in. thick		0 4 6
2345	Ditto ditto 6-in. high, 4¼-in. wide, 2-in. thick		0 3 6
2346	**Rectangular Battery Cells,** 5-in. high, 3¼-in. wide, 1⅞-in. thick		0 2 6
2347	**Porcelain Troughs** for Wollaston's Batteries		1 16 0
2348	**Glass Battery Cells** of various dimensions . from		0 4 6
2349	**Ebonite** ditto . from		0 4 6
2350	**Gutta Percha ditto Acid Holders,** various		
2351	**Platinum Foil and Wire** of all thicknesses, variable per oz.		1 15 0
2352	**Amalgamated Zinc Plates,** cut to various sizes, per lb.		0 1 6
2353	**Galvanic Conducting or Connecting Wires,** in pairs, for experimental or Medical use, insulated with **Cotton** or **Gutta Percha,** various lengths and sizes . from		0 2 6
2354	**Boxwood Charcoal,** for points . per oz.		0 0 6
2355	**Charcoal or Graphite Points,** for Electric Light, per pair		0 1 0
2356	**Gold, Silver, Platinum, Brass, Copper, Zinc, Iron, and Steel Wire and Foil,** for combustion, small reels	0 0 6	0 2 6

No.	Article	£ s. d.	£ s. d.
2357	**A Series of Six Smee's Batteries,** in a tray; apparatus for decomposing water into oxygen and hydrogen; V tube for decomposing neutral salts, various metal wires and foils for igniting and deflagrating, and a glass trough fitted for depositing metals by the electrotype or electro-gilding process. A very useful set for the use of Schoolmasters, for instructing a small class		3 10 0
2358	**Larger Series,** suited for Lecturers	5 5 0	6 6 0

The following values have been obtained for the Electro-Motive Force of the most useful battery combinations; they are the mean values of many careful determinations:—

Bunsen's Battery	839
Grove's "	829
Smee's "	210
Wollaston's "	208

GANOT.

ELECTRIC LIGHT.

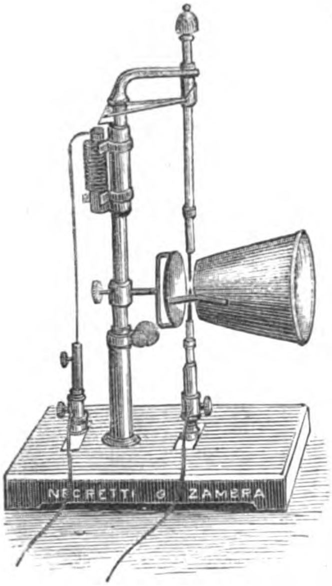


FIG. 2365.

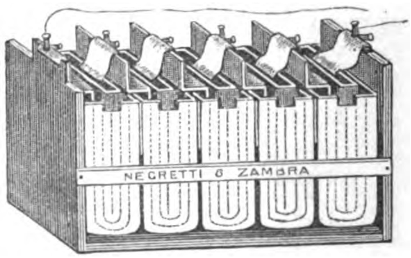


FIG. 2359.

IN 1801 the distinguished chemist SIR HUMPHRY DAVY first exhibited, at the Royal Institution of London, a series of brilliant experiments with the Electric Light, by means of a Battery of 2,000 plates, each 4 inches square; but it was not until the more permanent and powerful batteries of Daniell, Grove, and Bunsen were invented that the light became of any practical use.

As an illuminating agent for optical experiment it is invaluable; and it has been applied to Light-house service with very considerable success by Mr. Holmes, at Dungeness on the south-east coast of England, since June, 1862. This light is produced by a powerful Magneto-Electric Apparatus similar to one exhibited in action by Mr. Holmes at the Exhibition of that year. There are, however, still some difficulties to contend with, both as regards its cost and use that at present hinder its application as a mode of ordinary artificial illumination. Our brief remarks on this subject would hardly be deemed complete without referring to the names of Faraday, Daniell, Gassiot, Grove, and De la Rue as pioneer investigators in Voltaic Electrical Science.

The Apparatus we catalogue in this section is chiefly adapted for private experiment and the lecture-room; but by extending and enlarging the series of batteries an Electric Light can be supplied of sufficient intensity to illuminate a large area for which special quotations will be given upon application giving particulars of what is required.

		Each. £	s.	d.
2359	**A Set of 5 Grove's Batteries,** in a strong wood tray (as fig. 2359)	3	3	0
2360	**A Set of 10 ditto ditto** in tray	6	6	0
2361	**A Set of 5 Bunsen's Carbon Batteries,** in stout wood tray	2	15	0
2362	**A Set of 10 ditto ditto** in tray	5	5	0

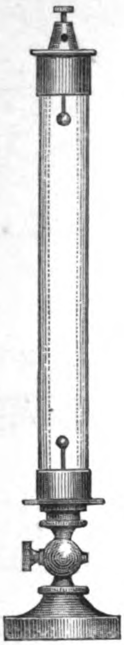


FIG. 2370.

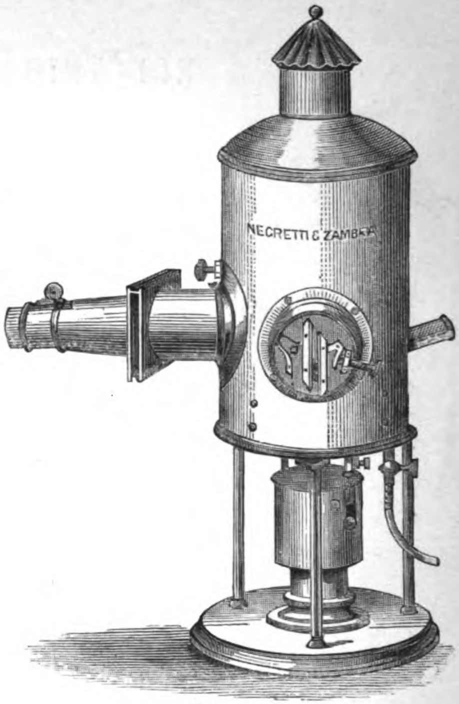


FIG. 2371.

		Each. £	s.	d.
2363	**A Set of 5 Callan's Cast Iron Batteries,** in stout wood tray	2	15	0
2364	**A Set of 10 ditto ditto** in tray	5	5	0
2365	**Self-acting Electric Lamp,** arranged on convenient stand (as fig. 2365), with adjustments to the Carbon Points	2	10	0
2366	**Electric Lamp,** without adjustments	2	2	0
2367	**Carbon Points or Rods**	0	1	6
2368	**Parabolic Reflectors,** for Electric Light, thickly plated, from each	2	2	0
2369	**Insulated (Gutta Percha)** Copper Wire, 8d. to 1s. 4d. per yard, price variable.			
2370	**Glass Tubes,** of large size, for exhibiting the Aurora Borealis; mounted with Stopcock and Metal terminals, for experimenting with various Gases, &c.; on a firm base (fig. 2370)	3	3	0
2371	**Electric Lantern,** an improved arrangement, having two sets of Condensers. With it the direct ray as well as the Spectrum may be projected upon the same screen without moving the Lantern. A gas jet is placed inside the Lantern, and suitable adjustments are provided for keeping the Carbon Points uniform in height. Price in the most complete form (fig. 2371)	25	0	0

45 Cells of Bunsen's Batteries are required for effectively working the Electric Light, or, 45 Cells of Grove's Batteries; Price for 40 Bunsen's, £20; 45 Grove's, £23.

For further particulars respecting Batteries, &c., see pages 380 to 391.

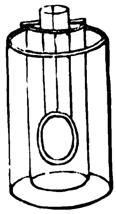
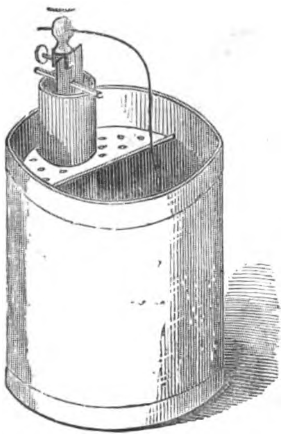
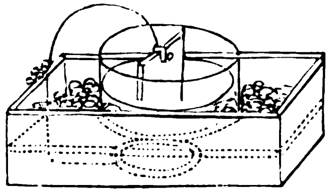


Fig. 2372.





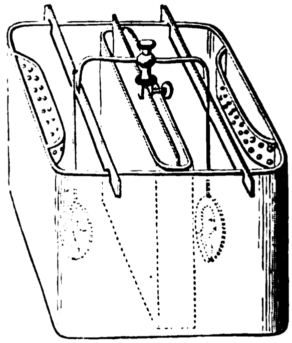


Fig. 2373. Fig. 2374. Fig. 2375.

ELECTRO-METALLURGICAL APPARATUS.

ELECTROTYPE APPARATUS IS NOW EXTENSIVELY USED FOR OBTAINING, BY GALVANISM, EXACT FAC-SIMILES OF ENGRAVED COPPER PLATES, WOOD ENGRAVINGS, MEDALS, PLASTER CASTS, ETC.

		Each. £ s. d.	Each. £ s. d.
2372	**Electrotype Apparatus,** consisting of earthenware jar, with porous pot, zinc and wire (fig. 2372)	0 1 6	0 2 6
2373	**Round Glazed Stoneware Troughs,** not permeable to sulphate of copper, with porous cell, zinc plate, binding screw and wire, suitable for copying medals, seals, plaster casts, &c. (fig. 2373)	0 7 6	0 10 6

This apparatus is most convenient and simple in its operation, and particularly adapted for those commencing to practice this interesting and useful art.

2374	**Electrotype Apparatus** (fig. 2374) very convenient for copying small seals, medals, &c.		0 15 0
2375	**Electrotype Trough,** 7 inches square, with flat porous cell, zinc plate and binding screw, and brass bars, on which to place the object to be copied (fig. 2375) .		0 16 0

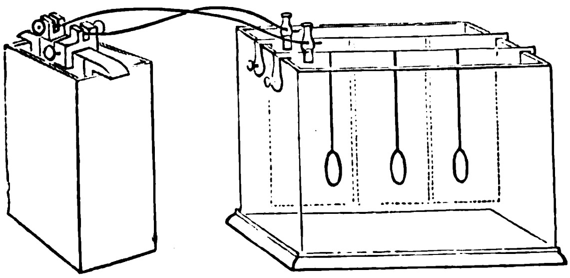


Fig. 2378.

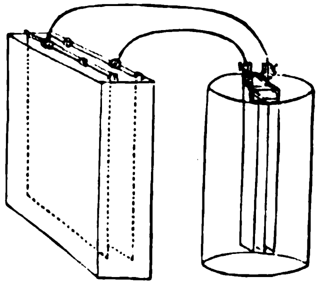


Fig. 2380.

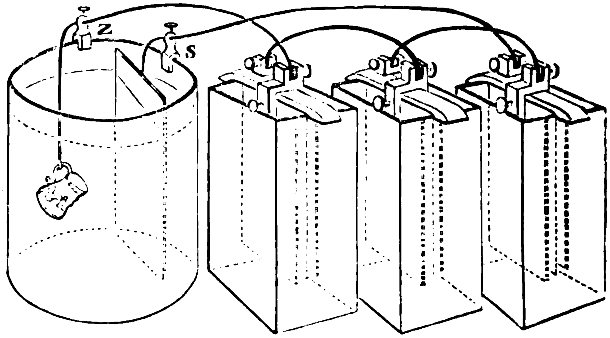


FIG. 2384.

		Each. £ s. d.	Each. £ s. d.
2376	**Electrotype Trough,** as No. 2375, 5 inches square .		0 12 6
2377	**Single Smee's Battery,** with Precipitating Trough, for making a number of small medals . . from		1 1 0
2378	**Larger ditto** (fig. 2378)		2 2 0
2379	**Electrotype Precipitating Trough,** large sized oval shape, with brass connecting bars (fig. 2379) . .		1 16 0
2380	**Vertical Precipitating Trough,** with Smee's battery, for obtaining duplicates of large engraved Copper Plates, Maps, &c. (fig. 2380)	2 0 0	3 10 0
2381	**Single Cell Apparatus,** for Electro-gilding or Plating (fig. 2381)		0 10 6

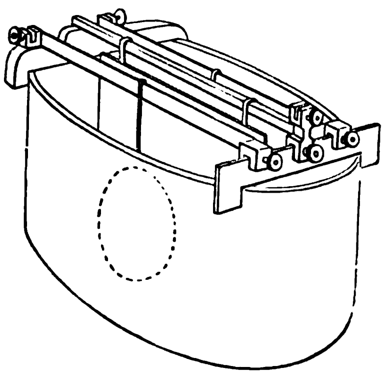


FIG. 2379.

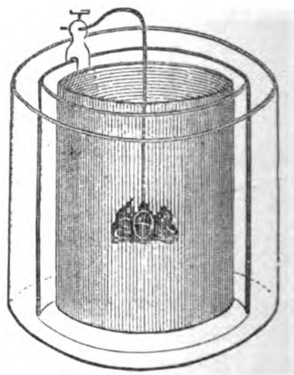


FIG. 2381.

2382	**Electro-Gilding and Plating Apparatus by the Battery Process,** with Glass precipitating trough, and one Smee's battery	0 18 6
2383	**Electro-Gilding and Plating Apparatus,** with 2 Smee's batteries	1 10 0
2384	Ditto ditto with 3 Smee's batteries (fig. 2384) .	2 0 0
2385	**Apparatus** for coating metallic surfaces with Aluminium and Silicium . . . . from	0 10 6
2385°	**Apparatus** for Nickel Plating fitted up to order.	

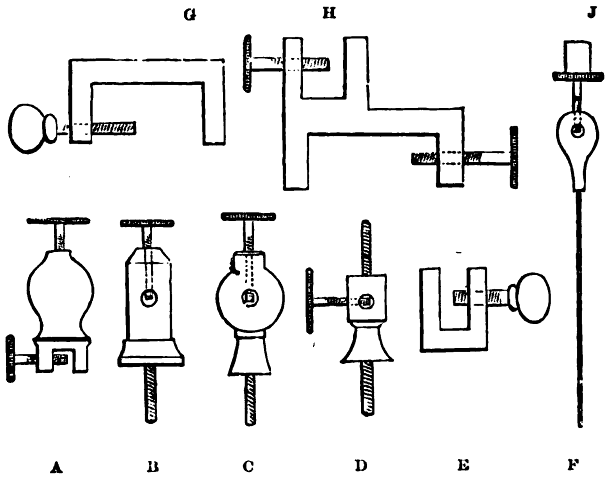


FIG. 2387.

No.	Article		Each. £	s.	d.
2386	**Platinized Silver,** for Smee's Batteries, price variable, about	per oz.	0	11	0

This averages about 3-oz. to the square foot, but can be had of various thicknesses.

2387 **Binding Screws,** or Terminals, of various forms and descriptions (fig. 2387) :—

Figs.	A	B	C	D	E	F	G	H
	9d.	8d.	8d.	1s. 8d. and	1s.	1s. 2d.	1s. 6d.	1s. 8d. and 2s.

			£	s.	d.
2388	**Gold Wire and Plate,** about	per dwt.	0	8	0
2389	**Silver ditto** ditto		0	5	6
2390	**Gold or Silver Solution,** ready for use in 3-oz. bottles		0	3	0
2391	**Sulphate of Copper**	per lb.	0	0	8
2392	**Sulphuric Acid**		0	0	4
2393	**Amalgamated Zinc Plates,** of all sizes	per lb.	0	1	6
2394	**Copper Wire and Plate,** of all thicknesses	ditto	0	1	6
2395	**Glass Cells,** of all sizes, mounted with Brass sliding bars for electro-gilding and plating	from	0	10	6
2396	**Gutta Percha or Ebonite Precipitating Cells,** of various forms				
2396°	**Tin Trays,** for impregnating plaster casts with boiling water, wax, &c.	from	0	2	0
2397	**Plumbago,*** pure, for Electrotype purposes	per oz.	0	0	4
2398	**Brushes** for applying Plumbago, &c.		0	1	0
2399	**Brushes** for Polishing and Bronzing electrotypes		0	9	0
2400	**Water of Air Stone,** for cleaning electrotypes		0	1	0

2401 **Porous Cells,** Round, of superior quality :—

Height	2½-in.	3½-in.	4½-in.	6 in.	12-in.	18-in.
Price	4d.	6d.	8d.	10d.	1s. 6d.	2s. 9d.

Porous Cells, Flat—

Height	2-in.	4-in.	2½-in.	3½-in.	3½-in.	7-in.
Width	3-½-in.	4½-in.	4¾-in.	5½-in.	6¾-in.	7-in.
Price	8d.	1s.	1s. 4d.	1s. 6d.	1s. 9.	2s.

2402 **Very superior Plaster of Paris Medallions,** for reproduction by the Electrotype process—

3d. 4d. 6d. 8d. 1s. 1s. 6d., and 2s. 6d. each.

* The use of Plumbago for giving to the surface of non-metallic bodies a conducting property, was first discovered by Mr. Robert Murray ; and the Society of Arts awarded to him their Silver Medal for the useful application of the substance.

MAGNETISM.

Native or Natural Magnets or Loadstone, an ore of Iron found in various parts of the world, appears to have been noticed in very early times, reference being made to it in some of the most ancient Chinese manuscripts, and in the writings of the Egyptian, Grecian, and Roman philosophers. Thales of Miletus supposed the mineral to be possessed of a soul or animating spirit, and Plato states that the cause of its attraction is Divine. The Greeks obtained it from the province of Magnesia in Lydia, and termed it "Magnes," and "Magnesian Stone," hence the modern terms Magnet, Magnetism, and Magnetic attraction. So universal has the knowledge been of the curious attractive properties of this stone, that from the earliest ages, in almost every language of the world it has some fanciful or characteristic name. The English word Loadstone or Lodestone is derived from the Icelandic "leiderstein," the leading stone, after the Saxon "lœdan" to lead. In Swedish it becomes "Segel-sten," the seeing stone. The Chinese call the stone "Thsu-cho" or love stone, from its apparent affection for Iron. The Sanscrit name "ayaskanta" has a similar meaning, and also the French "l'aimant." The remarkable property of the Magnet upon which the Mariners' Compass depends, namely, its indicating or pointing North and South, the Chinese affirm was known to them from all antiquity, though it appears to have been unknown to the philosophers of Greece and Rome. The earliest positive account of the Compass being in use in Europe is in an old French poem called "La Bible Guiot" found in a manuscript on Vellum written about the close of the twelfth century, and now in the Royal Library of Paris. Cardinal Jacques de Vitri, in his history of Jerusalem, published about the year 1200, speaks of the Magnetic Needle "as indispensable to those who travelled by sea." Dr. Gilbert of Colchester, in his famous Latin treatise on Magnetism published in the year 1600, *the first work on the subject published in England,* affirms that Paulus Venetus brought the Compass from China to Italy in 1260. It is certain that Vasco de Gama, the Portuguese Navigator, used the Compass in his voyage to India in 1497. The variation of the Compass Needle was first noticed by Columbus in his voyage resulting in the discovery of America in 1492, the declination of the Needle having been noticed some 200 years previously. If space permitted, we should have further quoted from a curious manuscript copy of a letter to be found at the University of Leyden written in 1296 by Petrus Peregrinus, "De Magnete," published at Augsburg in 1558, and the treatise of William Barlowe of Winchester, published in 1618, in which he speaks of the "nature, powerfulness, and strange properties of the Loadstone," and further describes it as "a base, contemptible, and dead creature as it seemeth to be, and yet filled with such excellent and wonderful vertue that all the gems of the world have not the like, neither if it were wanting could supply the want thereof or countervail the benefit that it bringeth to the life of man." Here we leave this most interesting history, and refer the curious to Sir W. Snow Harris's Treatise on Rudimentary Magnetism; Professor Barlow's Treatise on Magnetism, in the *Encyclopædia Metropolitana;* Dr. Rojet's *Treatise on Magnetism,* in the Library of Useful Knowledge; Sturgeon's *Annals of Electricity;* and a more recent paper in *Nature* of August 2nd, 1877, on Early Allusions to the Magnetic Needle, by Mr. H. Grimshaw.

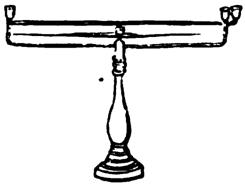


FIG. 2417.

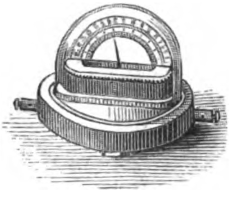


FIG. 2422

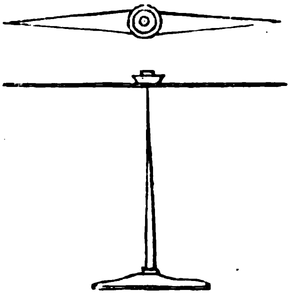


FIG. 2410.

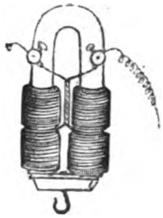


FIG. 2419.

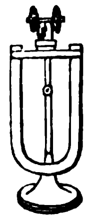


FIG. 2431.

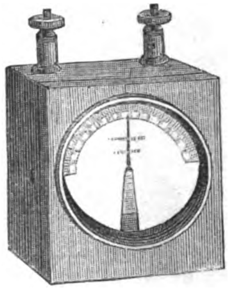


FIG. 2429.

MAGNETIC AND ELECTRO-MAGNETIC APPARATUS.

		Each. £	s.	d.	Each. £	s.	d.
2403	**Loadstones**, or Natural Magnets, specimens each 5s.; 7s. 6d.	0	10	6	1	1	0
2404	**Magnets**, Permanent of Steel, Horse-shoe shape, from 1 to 10 inches in length . each 6d., 1s., 1s. 6d.	0	2	6	0	5	0
2405	**Magnets**, Compound Horse-shoe form, of various sizes, with 2, 4, 6, or 8 Magnets, combined with soft Iron keepers . . . . . . 10s., 16s., 21s.	2	2	0	3	3	0
2406	**Magnet Bar**, 6-inches long, round or flat . . each				0	2	6
2407	**Magnets, Bar**, in pairs, of flat shape 6-inch and 12-inches long; in wood box, with soft Iron keepers . . .	0	10	6	1	1	0
2408	**Magnet Bar**, of large size, used for adjusting and correcting Ships, Compasses				0	16	0
2409	**Magnetic Needles**, mounted with Brass centres . .	0	3	0	0	6	0
2410	Ditto ditto Agate centres (fig. 2410) . . .	0	10	6	0	15	0
2411	**Stands or Supports** for ditto	0	1	6	0	2	6
2412	**Astatic Needles**, to suspend on a point, or by a silk fibre or hair	0	12	6	1	1	0
2413	**Dipping Needles**, with graduated **Arc** simple form .	1	5	0	1	10	0
2414	Ditto ditto with graduated **Circle** . . .	5	5	0	10	10	0
2415	**Dipping Needle**, extremely delicate, with divided vertical and azimuth circles, spirit level, and adjusting screws (fig. 2415)				15	15	0
2416	**Oersted's Apparatus or Experiment**, for showing the deflection of the magnetic needle by an electrical current passing above or below it, simple form .	0	7	6	0	10	6
2417	Ditto ditto (fig. 2417)	0	16	0	1	15	0
2418	**Oersted's Experiment**, of extra large size, the Needle mounted either vertical or horizontal, suited for Lecture Table				2	10	0

This apparatus will illustrate the principle of the electric telegraph in its most elementary and simple form.

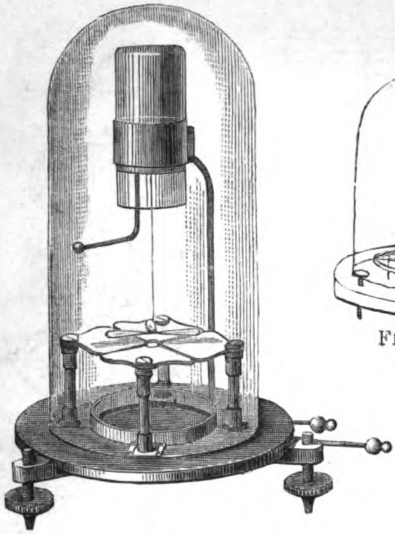


FIG. 2430.

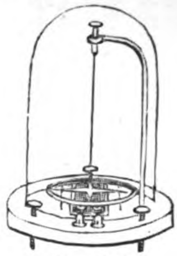


FIG. 2423.

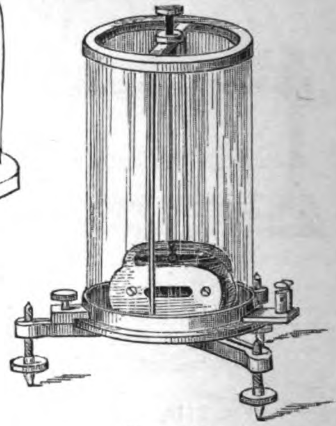


FIG. 2425.

No.	Description	Each. £ s. d.	Each. £ s. d.
2419	**Soft Iron Electro or induced Magnets,** consisting of a bar of soft iron, bent the shape of a horse shoe, and covered with insulated copper wire, forming, when in connection with a galvanic battery, a powerful electro-magnet capable of supporting a great weight (fig. 2419) 5s. 6d., 14s.,	1 1 0	1 10 0
2420	**Soft Iron Electro-Magnet,** mounted on a tripod stand, with weight	0 18 0	1 10 0
2421	**Soft Iron Electro-Magnet,** on a very large scale, for sustaining immense weights		3 3 0
2422	**Galvanometer,** simple form, for measuring the force of electro-magnetic currents (fig. 2422)	0 15 0	1 1 0
2423	**Galvanometer,** with Astatic Needles, of low resistance, for Thermo-Electrical experiments, and for measuring the conductivity of wires, with levelling screws to glass shade (fig. 2423)	2 10 0	3 3 0
2424	Ditto ditto with attached Mirror		3 10 6
2425	**Galvanometer,** with Astatic needles, index torsion key, moveable coil, and levelling screws, very delicately adjusted with mirror about 1,500 ohms resistance (fig. 2425)		5 10 0
2426	**Galvanometer,** with an extremely fine and long coil of wire, as used by Du Bois Raymond in his researches on the existence of electrical currents in animals .		15 15 0
2427	**Reflecting Galvanometer,** Sir W. Thomson's, with Astatic Needles, on Tripod Stand, short thick wire, with Lamp-stand and Scale		11 11 0
2428	Ditto ditto with about 2,500 ohms resistance		13 13 0
2429	**Detector Galvanometer,** with Vertical Needle (fig. 2429)		3 10 6
2429°	**Sine Compass or Galvanometer,** for measuring powerful galvanic currents (fig. 2429°). For description of construction and use, see Ganot's *Physics* . price		15 15 0

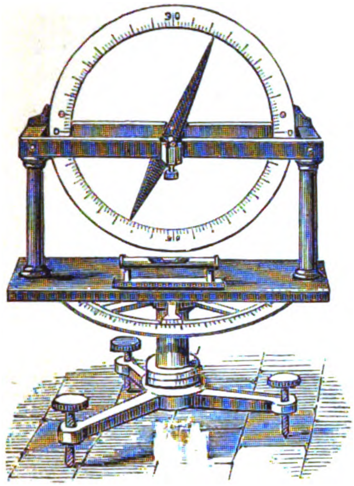


FIG. 2415.

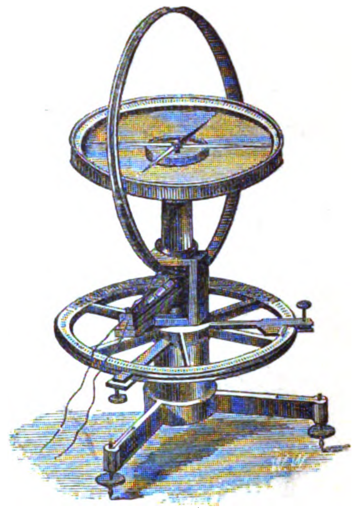


FIG. 2429*.

No.	Item	Each. £	s.	d.	Each. £	s.	d.
2430	**Quadrant Electrometer,** Thomson's arrangement, suited for Lecture Table, will show the tension of a single cell (fig. 2430)				4	10	0

A delicate form of Electrometer for the quantitative measurement of electrical charge. The principles and use of Thomson's instrument will be found in detail at page 130 of Negretti and Zambra's *Treatise on Meteorological Instruments.* Price 5s.

No.	Item	Each. £	s.	d.	Each. £	s.	d.
2431	**Ritchie's Experiment,** exhibiting the rotation of an electro-magnet between the poles of a permanent horse-magnet (fig. 2431)				0	14	0
2432	**Ritchie's Experiment,** with adjusting screws . .				0	18	6
2433	**Gamut of Bells on Stand,** with Ritchie's Experiment, rotating in the centre, carrying a clapper which strikes the bells in succession similar to fig. 2240 .				3	3	0
2434	**De la Rue's Electrical Discharger,** a contrivance for using various differently prepared carbon points, &c. (fig. 2434)				2	2	0
2435	**Sturgeon's Semi-spiral Disc,** for exhibiting the various coloured sparks evolved by different metals (fig. 2435)				2	12	0
2436	**Bain's Apparatus** for taking Soundings at Sea by means of an induced magnet (fig. 2436)				4	0	0
2437	**Magnetic Toys,** consisting of fishes, ships, swans, &c., to illustrate magnetic attraction and repulsion each				0	1	6
2438	**Ampere's Apparatus,** for exhibiting the rotation of a cylindrical galvanic battery round the pole of a magnet				0	14	0
2439	**Horse-shoe Magnet on Brass foot,** for ditto . .				0	12	0
2440	**De la Rive's Floating Battery** (fig. 2440)				0	7	6
2441	Ditto ditto with elongated Helical Coil (fig. 2441)				0	7	6
2442	**Marsh's Apparatus,** for showing the vibration of a Suspended Wire transmitting an electrical current when submitted to the influence of the poles of a magnet .				0	10	6

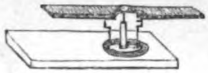


Fig. 2445.

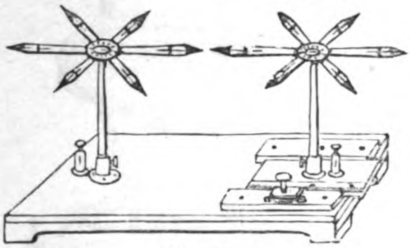


Fig. 2434.

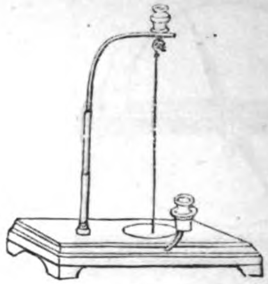


Fig. 2443.

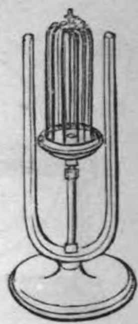


Fig. 2452.

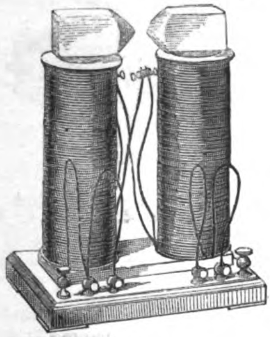


Fig. 2458.

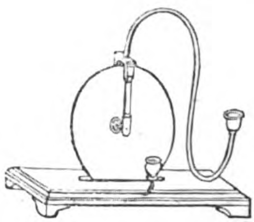


Fig. 2446.

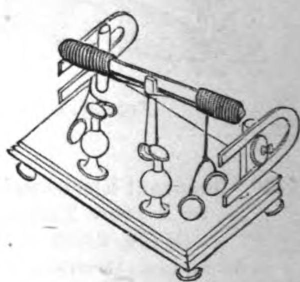


Fig. 2449.

No.	Article	Each. £ s. d.	Each. £ s. d.
2443	**Faraday's Apparatus** for showing the rotatory motion of a wire transmitting an electrical current round the pole of a magnet (fig. 2443)		0 10 6
2444	**Faraday's Rotating Needle, and Marsh's Vibrating Wire,** in the same instrument		0 15 6
2445	**Terrestrial Rotating Magnet** (fig. 2445)		0 14 6
2446	**Sturgeon's Rotating Disc** (fig. 2446)		0 15 0
2447	**Magnetometer** (Sturgeon's), to exhibit the properties of different metals under the influence of a powerful magnet		2 10 0
2448	**Apparatus** to exhibit the rotation of a Copper Disc under the influence of a revolving magnet		6 10 0
2449	**Dr. Golden Bird's Vibrating Electro-magnet** (fig. 2449)		2 10 0
2450	**Barlow's Stellar-formed Rotating Wheel**		0 10 0
2451	**Double Wheel,** of the Stellar form		0 18 0
2452	**Apparatus,** exhibiting a Coil of Copper Wire rotating between the poles of a magnet (fig. 2452)		0 16 0
2453	**Glass Tube,** surrounded by a Coil of Copper Wire for magnetizing steel needles by induction		0 2 6
2454	**Electrepeter,** for reversing the direction of galvanic or electro-magnetic currents		1 10 0
2455	**Dr. G. Bird's Inversor** for ditto (fig. 2455)		1 1 0
2456	**Bachoffner's Electrepeter,** for ditto (fig. 2456)		1 6 0

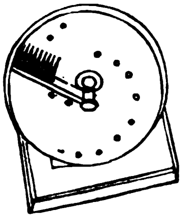


FIG. 2435.

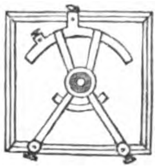


FIG. 2455.

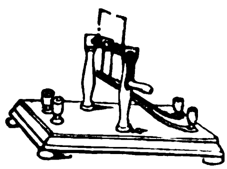


FIG. 2456.

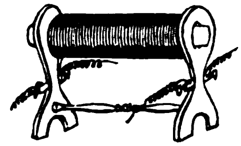


FIG. 2461.

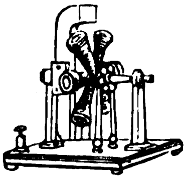


FIG. 2467.

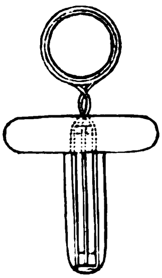


FIG. 2440.

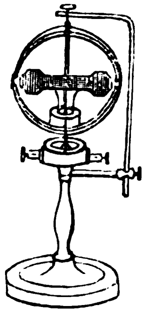


FIG. 2457.

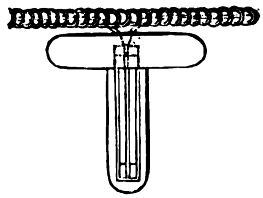


FIG. 2441.

No.	Description	Each. £ s. d.	Each. £ s. d.
2457	**Apparatus** for showing the opposite rotation of hooped permanent magnets and a straight electro-induced magnet (fig. 2457)		1 18 0
2458	**Powerful Electro or Induced Magnet,** having double wires, and moveable coils for Dia-Magnetic experiments (fig. 2458)		12 12 0
2459	**Compound Electro-Magnetic Apparatus,** consisting of a horse-shoe magnet, on brass foot, with levelling screws and sliding pillar, two rotating armatures, rotating coil, Ampere's bucket, mobile wire frame, helical coil, rotating cylinder, and two flood cups		3 10 0
2460	**Callan's Primary and Secondary Coils on Stand** (see also fig. 2461)		1 16 0
2461	**Apparatus** to illustrate the phenomena and construction of Induction Coils, with binding screw connections (fig. 2461)		2 2 0

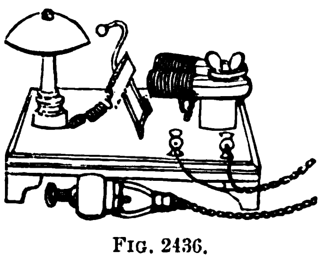


FIG. 2436.

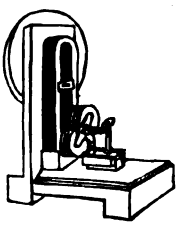


FIG. 2464.

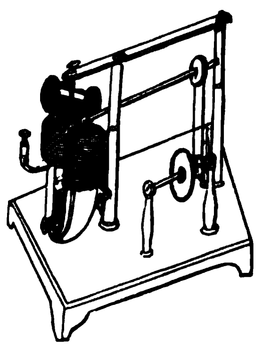


FIG. 2465.

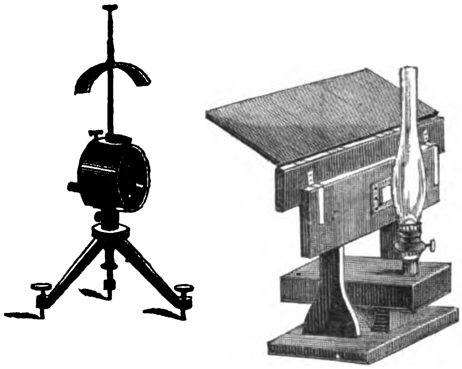


FIG. 2462.

		Each. £ s. d.
2462	**Sir W. Thomson's Astatic Reflecting Galvonometer,** having 4 coils, upwards 5,000 ohms resistance, with Lamp-stand and Scale of the most recently improved construction (fig. 2462)	25 0 0
2463	**Set of Shunts** for above, $\frac{1}{9}$ $\frac{1}{99}$ and $\frac{1}{999}$ the resistance of the Galvanometer	4 4 0
2464	**Magneto-Electric Machine,** Clark's arrangement, consisting of a combination of highly charged horse-shoe magnets, mounted on a stand, with multiplying wheel and rotating armatures, for obtaining Quantity and Intensity of effects. The machine is fitted with apparatus for producing magneto-electric light and heat, electro-chemical decompositions, the ignition and deflagration of metals, the rotation of wires, and powerful action upon the human body; in cabinet (fig. 2464)	12 12 0
2465	**Model Electro-Magnetic Engine, driving a small Water Pump, or Grindstone**	3 3 0
2466	**Model of Saw Mill driven by Electro-Magnetism,** consisting of a powerful electro-magnet on stand, with rotating armature, driving a circular saw (fig. 2466) . 4 4 0	6 6 0
2467	**Electro-Magnetic Motive Engines,** as fig. 2467, of large size, worked by the combination of electro-magnetic forces. Made to order and drawings.	

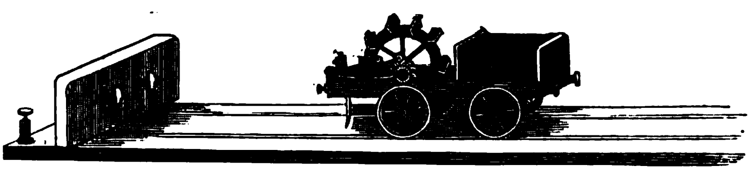


FIG. 2468.

2468	**Model Electro-Locomotive Engine** (fig. 2468), with a Straight Railway about four feet long. The engine has a self-acting reversing apparatus, causing the engine to run backwards and forwards on the line; Two cells of Callan's or Bunsen's Batteries will work this engine effectively. Complete, with two batteries	12 12 0

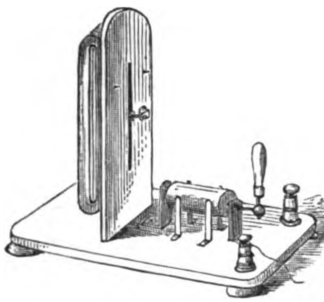


FIG. 2469.

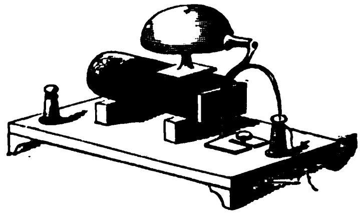


FIG. 2470.

No.	Article	Each. £ s. d.	Each. £ s. d.
2469	**Model Electro-Magnetic Telegraph,** fitted with reversing brake, in a sinple form on a stand, suited for Lectures or the Class room (fig. 2469) . . .		3 3 0
2470	**Model Electro-Magnetic Signal Bell,** to be used in conjunction with above (fig. 2470)		1 12 0
2471	**Copper Wire,** covered with **Cotton,** superior quality, in long lengths. The following prices are variable :—		

	Nos. 12 to 14.	15 to 18.	19 to 22.	23 to 26.	30 to 32.
Per lb.	3s.	4s.	5s.	6s.	8s. 6d.

No.	Article	Each. £ s. d.	Each. £ s. d.
2472	**Copper Wire,** covered with **Silk,** to order, per lb., variable.		
2473	Ditto ditto covered with **Gutta Percha,** in lengths of 100 feet and upwards of various sizes, from, per length		1 1 0
2473*	**Assortment of Electro-Magnetic Apparatus,** packed in a strong Pine Case, to illustrate the first principles of the science	3 3 0	5 5 0

These sets are so arranged as to extend and complete those of Galvanic Apparatus, page 396.

Of the terms POSITIVE *and* NEGATIVE.—There is nothing which has a greater tendency to confuse the mind, with regard to voltaic apparatus, than the terms *positive* and *negative* end of a battery. "The fundamental principle," observes Mr. Walker, "which cannot be too strongly enforced, is that the passage of the electricity is from the zinc to the copper." This, of course, refers to the common forms of battery—Cruickshank's, Babington's, &c. In the arrangement of Smee, the passage of the electricity is from the zinc to the silver; in Grove's battery, from the zinc to the platinum. "The positive is the end where the electricity leaves the battery; the negative where it re-enters it. The direction taken by the current being ascertained by the mere inspection of the situations of the two metals in a cell, the other points follow as a necessary consequence." Now, taking the Smee's battery as an illustration, it must be clear, that as the electricity passes from the zinc to the silver, it would leave the battery by the wire attached to the silver plate, and having passed through the interposed apparatus, would return to the battery by the wire attached to the zinc plate; the silver, which is the *negative metal,* forming the *positive end* of the battery; and the zinc, the *positive metal,* forming the *negative end.* In like manner with all the batteries we have described, the zinc, though the *positive metal,* is the *negative pole.*

THERMO-ELECTRIC APPARATUS.

FIG. 2474.

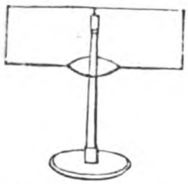


FIG. 2475.

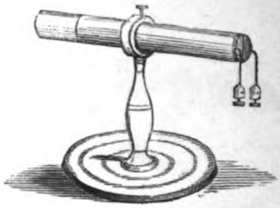


FIG. 2476*.

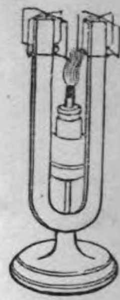


FIG. 2476.

No.	Description	Each. £ s. d.	Each. £ s. d.
2474	**Rectangular Wire Frames,** with four branches composed of dissimilar metals, with a fine point on the rectangle, for suspending on the pole of a magnet, to show thermo-magnetic rotation (fig. 2474) . .		0 15 6
2475	**Compound Frames and Wires** of the various metals, for exhibiting thermo-electric rotations (fig. 2475) from		0 12 6
2476	**Thermo-Rotating Compound Rectangular Frames,** composed of platina and silver wires, mounted on a horse-shoe magnet, complete, with spirit lamp (fig. 2476)		1 10 0
2476*	**Compound Bar of Antimony and Bismuth,** mounted on a Brass Stand, for producing a Thermo-electric current by the application of Heat to the extremity .		1 1 0
2477	**Melloni's Thermo-Electric Pile** (fig. 2477)	2 2 0	3 3 0
2478	**Melloni's Thermo-Electric Pile or Battery** of 25 pairs of small bars of Antimony and Bismuth, in a convenient frame on a foot, with binding screws for connections, fitted with cones, as used by Professor J. Tyndall, F.R.S., in his experiments with Caloric (fig. 2478)		4 4 0

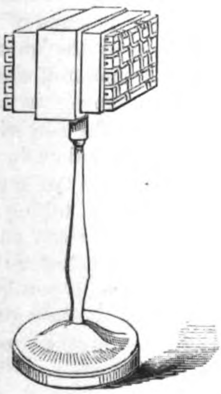


FIG. 2477.

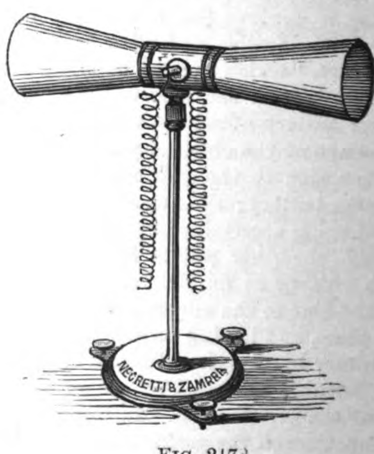


FIG. 2478.

INDUCTION COILS, VACUUM TUBES, &c.

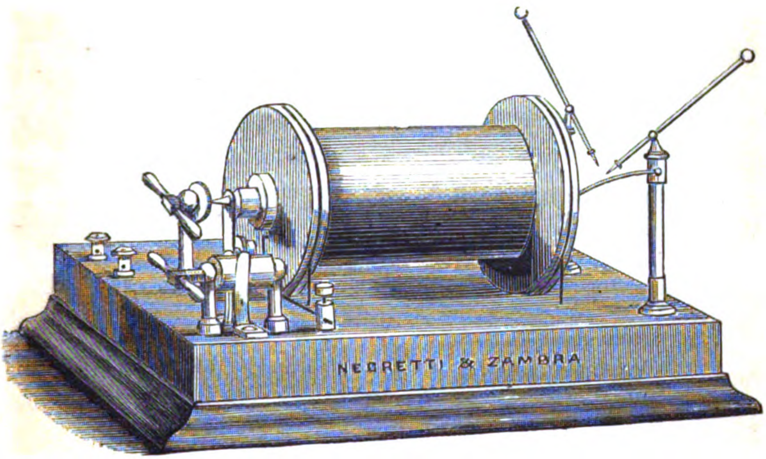


FIG. 2479.

No.	Description	Each. £ s. d.	Each. £ s. d.
2479	**Negretti and Zambra's Improved Ruhmkorff's Induction Coil** (Inductorium of the German Physicists) to give 3½-inch spark in air (fig. 2479) .		15 15 0
2480	Ditto ditto to give 2½-inch sparks . . .		12 12 0
2481	Ditto ditto to give 1-inch sparks . . .		10 10 0
2482	Ditto ditto small size, ½-inch sparks . . .		5 5 0
2483	**Grove's Batteries for above,** see page 390.		
2484	**Gassiot's Vacuum Tubes,** of numerous shapes, for exhibiting the interesting electric stratification and brilliant coloured light produced by the passage of electricity through rarefied air, gases, &c. The metal terminals of these tubes are formed of Platinum or Aluminium wires. Price various 25s., 26s.		
2485	**Carbonic Acid Vacuum Tube,** with stick of Caustic Potash at one end	1 5 0	1 10 0
2486	**Carbonic Acid Vacuum Tube,** with Carbon Terminals .		1 5 0
2487	**Geissler's Vacuum Tubes,** hermetically sealed. All of these tubes have been filled with different gases, such as Hydrogen, Nitrogen, Oxygen, Carbonic Acid, Phosphoric Acid, &c., and then exhausted as perfectly as is possible :—		

Vacuum Tube, A (fig. 2487)		£1 6 0	Vacuum Tube,	G .	£1 10 0
Ditto	D . .	0 15 0	Ditto	H .	1 5 0
Ditto	E . .	1 10 0	Single Garland Tube,	B .	1 10 0
Ditto	F . .	1 10 0	Double ditto	C .	2 0 0

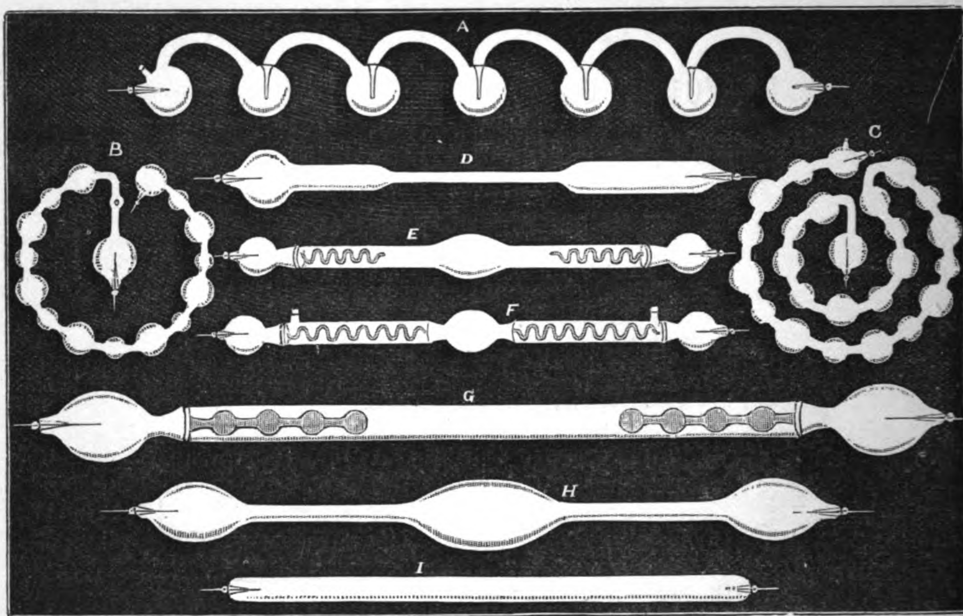


FIG. 2487.

		Each. £ s. d.	Each. £ s. d.
2488	**Vacuum Tubes,** for exhibiting illuminated names or mottoes according to size and design, made to order .	price various.	
2489	**Large-Sized Vacuum Tube,** with the words, "God save the Queen"		5 5 0
2490	Ditto ditto smaller		2 10 0
2491	**Diadem or Coronet Vacuum Tubes**	2 10 0	3 10 0
2492	**Sieman's Ozone Tube and Stand**		1 5 0
2493	**Apparatus** for showing the Rotation of a Spark round an Electro Magnet		3 10 0
2494	**Gassiot's Cascade,** large size		3 10 0
2495	**Gassiot's Revolving Star,** best form		5 5 0

This apparatus is an adaptation of Sturgeon's Revolving Electrical Spiral. Attached to the axis of the machine is a piece of varnished wood or vulcanite, fitted at each end with metallic spring clips for holding securely the vacuum tube to be revolved. Two fine insulated wires in connection with the metal clips and terminal wires of the vacuum tube are carried down the back of the wood arm to the axis, and are in metallic connection with two binding screws on the base of the apparatus by which the induction coil is to be placed in contact. The connexions having been carefully made, the tube is caused to be very rapidly revolved by the action of the large wheel on a small one placed at the axis, and the result is a beautifully iridescent star, the colours, &c., varying with the form of the tube employed.

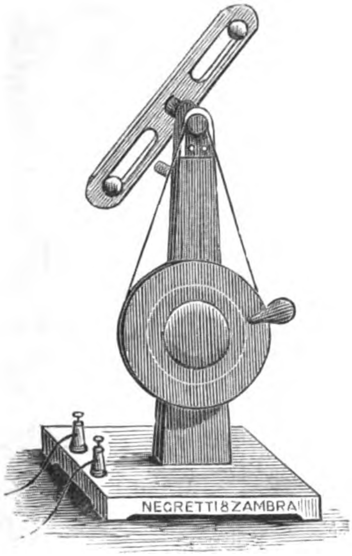


FIG. 2507.

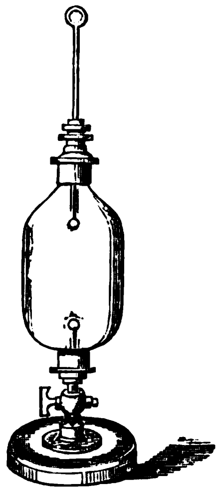


FIG. 2496.

		Each. £	s.	d.	Each. £	s.	d.
2496	**Apparatus** for exhibiting the Luminous Electric discharge in vacuo (fig. 2496) from Carbon Points or Metal Terminals, sometimes called the Electrical Egg				3	3	0
2497	**Glass Tube** for similar experiments, fitted with a stop-cock, various lengths (see page 307) . . from				2	2	0
2498	Ditto ditto of Uranium glass . . . from				4	4	0
2499	**Eudiometer,** for use with Inductorium				0	7	6
2500	**Uranium Glass Vessel,** for showing Fluorescence from				0	10	6
2501	**Ruhmkorff Coils,** small size				1	5	0
2502	Ditto ditto with Commutator				1	12	0
2503	Ditto ditto				2	2	0
2504	Ditto ditto	3	3	0	4	4	0
2505	**Geissler's Vacuum Tubes,** small size, various forms, each 5s.,	0	7	0	0	10	6
2506	**Geissler's Tubes,** a set of four medium size, for use with the above coils				1	1	0
2507	**Whirling Apparatus for Gassiot's Star,** for large sized Vacuum tubes (fig. 2507)				4	12	0
2508	Ditto ditto for small tubes of the same construction				1	16	0
2509	**Revolving Colour Disc,** for use with No. 2507, exhibiting white light, and proving that the induction spark is not continuous				0	10	6

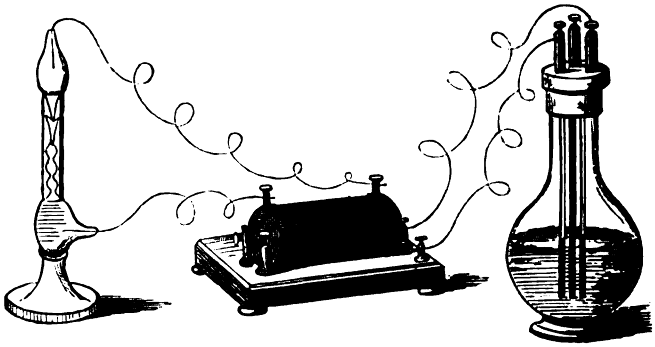


FIG. 2510.

No.	Description	Each. £ s. d.	Each. £ s. d.
2510	**A Set of Apparatus** as fig. 2510, including one small Rhumkorff's Induction Coil, one Bichromate Battery, and one Vacuum Tube on stand . . .		3 10 0
2511	**A Set of Apparatus,** consisting of one Induction Coil, one Bichromate Bottle Battery, five small Vacuum Tubes of various designs, and a Whirling Apparatus, with connecting wires, in Pine Box .		6 6 0
2512	**Electro-Motive Engine,** arranged for rotating small Geissler's Tubes, an exceedingly interesting and attractive model, the movement and the light being entirely produced by Electrical Agency . . .	4 4 0	5 5 0

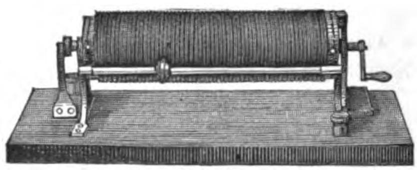


FIG. 2514.

No.	Description	Each. £ s. d.	Each. £ s. d.
2513	**Wheatstone's Rheostat,** for adjusting and regulating an electric current so as to obtain any constant degree of force		4 4 0
2514	**Wheatstone's Rheostat,** for ascertaining the amount of resistance offered by various lengths of wire to a given current of electricity (fig. 2514) . . .		5 5 0
2515	**Wheatstone's Apparatus,** for determining the Differential Resistance of various metal wires, &c. &c.		2 10 0

2516 **Table of relative lengths and weights of Copper Wire,** covered with **Cotton,** as used for Electric, Galvanic, Electro-magnetic, and **Telegraphic** purposes :

Nos.	6.	9.	12.	14.	18.	23.	32.	34.
Feet	8	18	39	48	130	360	1,300	2,000 to the lb. weight.

For the price which is variable, see page 409, No. 2471.

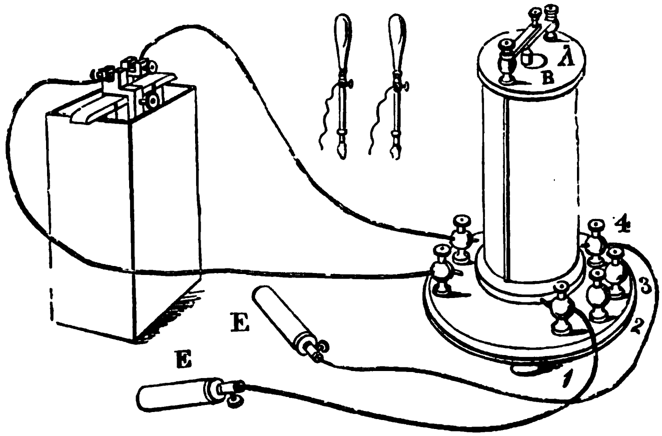


FIG. 2517.

ELECTRO-GALVANIC MACHINES.

FOR ADMINISTERING MEDICAL GALVANISM.

THE application of Electricity as an agent for the relief of disease, must have been subsequent to the discovery of Muschenbrock's Leyden vial in the year 1745. The shock occasioned by this instrument appeared at that period so tremendous, that the most absurd accounts were related of it. It appears that Abbé Nollet was the first who directly applied Electricity for the cure of disease. He had observed that its continued action on liquids accelerated their evaporation. and that this evaporation was far more considerable when the vessels which contained them had a large opening and were formed of good electrical conductors. Boze at the same time observed that electrified water issued from capillary tubes in the form of rays in lieu of drops. These two experiments were regarded as fundamental ones by those physicians who directed their attention to the application of electricity as a medical agent. From this period down to the present day the physiological effects of Electricity and Galvanism upon the human body have attracted the attention of both English and Continental physicians and surgeons. The records of their experiments and investigations would occupy too much space for our pages, therefore we must refer our readers to the works of Valli, Carpue, C. H. Wilkinson, Matteucci, Dr. Golding Bird, and G. T. Fisher as excellent authorities on the subject. The scientific application of Electricity to medicine has made less progress than the success which has really, in many cases, attended its use, might have been justly expected to produce. It appears, from every trial of its powers hitherto made, that, under judicious management, its application has never been known to produce consequences decidedly injurious, while in many of the most distressing disorders, it has frequently been of considerable service. These are powerful recommendations; and when it is added that it is an external and by no means painful remedy, and that it may be applied immediately to the affected part, without interfering with any other organ, its advantages must appear to be considerable. At the same time it must be remembered, that it is a remedy of such a nature, that often a long continuance of its application is in many cases necessary before any decided and beneficial results can be obtained.

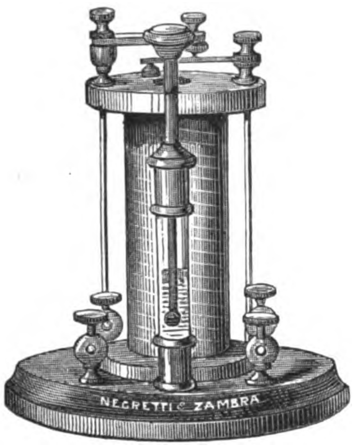


FIG. 2518.

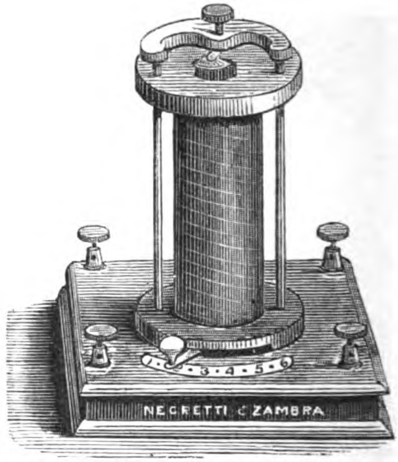


FIG. 2521.

No.	Description	Each. £ s. d.	Each. £ s. d.
2517	**Electro-Galvanic Coil Machines** for Medical use, with four binding screws, to regulate the intensity of the shock, Nos. 1 and 2 being the lowest in strength, 1 and 3 the medium, and 1 and 4 the full power of current (Coil as shown in fig. 2517)		1 10 0
2518	**Electro-Galvanic Coil Machines**, with Lockey's Water Regulator, a very elegant method of controlling the force of the current, but perhaps not quite so definite as the previous arrangements (fig. 2518) . . .		1 10 0
2519	**Electro-Galvanic Coil Machines**, either with the Four regulating Binding Screws, or the Lockey's Water Regulator, packed in polished mahogany case, with one of Smee's Batteries, Conducting Wires, and Shock Handles, complete, very portable and convenient for medical practice		3 3 0
2520	**Electro-Galvanic Coil Machine**, with two of Smee's Batteries, in mahogany case, &c.		4 4 0
2521	**Electro-Galvanic Coil Machine**, larger and most improved form, with a simple and effective Lever contrivance for regulating the shock, complete, in mahogany case, with two large Smee's Batteries, flexible Conducting Wires, Shock Handles, Directors, &c., with directions for use (fig. 2521) . . .	6 6 0	8 8 0
2522	**Larger Coils and Batteries** of any number of elements fitted to above, for Hospital use, made to order.		

These instruments can be had of either Primary or Secondary arrangement, or both combined in one coil.

Full instructions sent with each apparatus, that will enable patients to use them with the greatest ease and convenience. Various forms of Directors for use with Electrical Apparatus will be found at No. 2526, and page 418.

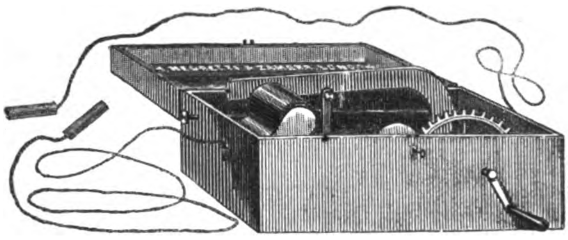


FIG. 2524.

MAGNETO ELECTRIC MACHINES.

As Electricity, under certain conditions, gives rise to Magnetism, so Magnetism, in its turn, can be made to evolve Electricity. Faraday was the first to discover that magnetism conjoined with motion may be made the source of electricity. It would be foreign to a work of this kind, and would carry us beyond our limits, were we to attempt to describe the beautiful experiments by which that philosopher was enabled to prove the fact; suffice it to say, that on this principle have been constructed machines, by which a current of electricity is set in motion without the aid of a battery. The modern form of one of these instruments is seen in the figure, No. 2524. It consists of a horse-shoe magnet, which is fixed to a frame; opposite its poles is placed what is termed the armature, which can be rapidly revolved by means of a multiplying wheel. The armatures are nothing more than electro-magnets, and by means of the wheel each pole of the armature is brought in rapid succession opposite each pole of the magnet, and that as nearly as possible without touching, and a most brilliant succession of sparks, forming almost a continuous light, is produced.

Between the years 1831 and 1836 many forms of Electro-Magnetic Machines were invented and constructed by Pixii, Saxton, Bachoffner, and Clark. These will be found fully described in most works on Voltaic Electricity. At page 408, No. 2464, we give an engraving and general details of Clark's Machine, an improved form of Bachoffner's, now only used to demonstrate the various facts known in connection with Electro-Magnetism. Our wood-cut, No. 2524, exhibits the modern improved form of Magneto Machine, as specially arranged for **Medical Purposes.** This armature is rotated by a winch handle, setting up an induced current of electricity in the armature, this current being conducted to the patient by convenient flexible wires and directors or shock handles.

The strength or force of the current is regulated by the removal of the soft iron keeper entirely from the end or poles of the magnet, or gradually bringing it closer to the magnet, the most powerful action being obtained when the keeper is entirely removed, and the lowest action when the keeper is in close contact with the magnet.

2523 **Negretti & Zambra's Improved Magneto Electro Machine**, a most convenient and portable apparatus for the application of Medical Galvanism; *no acid required*, the instrument always ready for use, and the strength of the currents can be regulated from the most feeble to the highest intensity. Price, in strong box, with directors . . . £1 10 0 £2 2 0

2524 **Magneto Electro Machines**, best finish, and Mahogany box (fig. 2524) 2 10 0

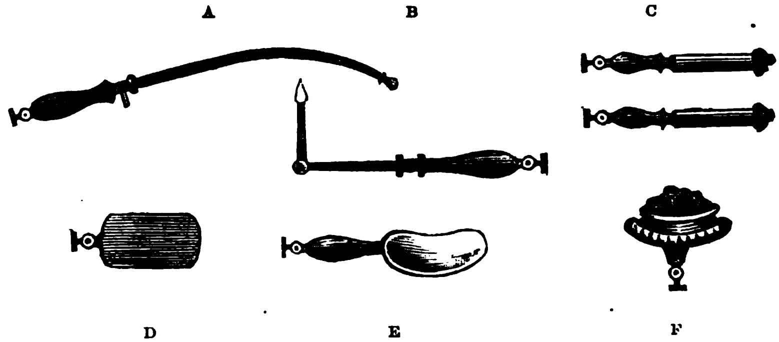


FIG. 2526.

No.	Item	Each. £ s. d.	Each. £ s. d.
2525	**Cruickshank's Battery** (see fig. 2297, page 388), for Medical use, where it is desirable to use the actual current without the interruption of a coil . . .		1 12 0
2526	**Sponge Directors** for the hands (fig. C) . from, per pair		0 4 6
2527	Ditto ditto Flat, large surface (fig. F) . .		0 8 6
2528	**Shock Handles**, plain tubes and wires		0 2 6
2529	**Curved and Bent Directors** (or Rheophores), for the internal application of Electricity (figs. A & B) . .		0 10 6
2530	**Flat and Curved Surface Director** (figs. D & E) . .	0 5 6	0 7 6
2531	**Faraday's Wire Brush Directors** (fig. 2531) . .		0 5 6
2532	**Flexible Conducting Wires**, of various lengths, from per pair		0 3 6

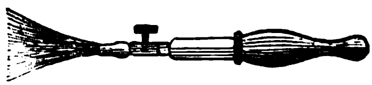


FIG. 2531.

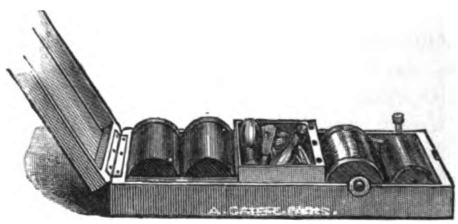


FIG. 2533*.

2533 **Pocket Medical Induction Coil** (fig. 2533). In this appparatus the electromotor used is Pile Marie Davy, a voltaic battery having bi-sulphate of mercury and carbon electrodes. The cell of this battery is made of vulcanite in the form of a tray about 1¾-inch square, and by 1-inch deep; into this tray is placed a slab of graphite, and above it a piece of zinc. Metal fittings are attached to the cell to connect the elements to the coil. To charge the battery, a small quantity of Bi-Sulphate of Mercury is placed on the Carbon, which is to be saturated with water, and then have the zinc plate placed upon it, observing that the zinc does not in any way touch the carbon. The battery will now be in action, and the vibrating contact break should be

adjusted until steady vibrations are obtained. At the side of the box will be found metallic fittings, by which shock handles or directors are to be connected, and the current of electricity conveyed to any part of the person to be operated upon. The strength of the current is regulated by a brass tube, covering the bundle of iron wire in the centre of the coil. When this brass tube entirely covers the iron wire, the action of the coil is very feeble, but when it is fully drawn out, and the bundle quite uncovered, the maximum amount of power is obtained.

It is requisite frequently to clean out the battery when in constant use; this is simply done by washing in plenty of water the cell, carbon, and zinc (to remove all the yellow deposit), and then replace the elements, with a fresh charge of Bi-Sulphate of Mercury. In handling this preparation great care should be taken to prevent it coming in contact with any gold or silver articles, as the mercury would amalgamate with these metals, and be very troublesome to remove; in fact, delicate jewellery would be utterly spoilt. Various shock handles and directors and flexible wires for applying the galvanic current are supplied with each instrument.

2533* **Portable Medical Induction Coil** (fig. 2533*) £4 4 0

2534 **Induction Coil Apparatus,** similar to above, with Chloride of Silver and Zinc; Battery, clean and convenient in use and size £5 5 0 £6 10 0

HINTS FOR APPLYING MEDICAL GALVINISM.*

1. Feeble powers should always be first tried; these should be gradually augmented, and the use of such finally persisted in, as, without producing any violent effects, appear to make a decided impression on the disease.

2. Galvanism as a remedial agent, must not be hastily given up because of its beneficial effects not immediately appearing, for these, generally speaking, require considerable time to be developed.

3. Electricity or Galvanism should not be relied on exclusively in the treatment of diseases, but should rather be considered as auxilliary to other methods of cure.

4. To the preceding we shall add, that in cases where the continuous current may be deemed most advisable, it would be well to use batteries composed of plates having an extended surface, there being reason to believe that the curative influence of galvanism in this form depends, not upon its intensity, but upon the quantity of it set in motion."

To these principles we may add, that in all cases where it is necessary that the interrupted current should be administered, the electro-magnetic coil machine will be found much more manageable, much more portable, and equally powerful, if not more so than the galvanic battery itself; but in cases where the continuous current is required, the battery alone should be used.

Sig. Orrioli (an Italian Philosopher) recommends that before attempting to apply Electricity therapeutically, we should study the nature of the secretions produced, in order that we may be enabled to create in the secretory organ a proper electrical state for bringing about contrary effects. These secretions will be Acid, Alkaline, or Neutral. If they be acid or alkaline no difficulty will exist; if they are neutral, we should apply to the affected part the pole of the battery opposed to that electrical state which belongs to the normal condition of this part.

* G. T. Fisher's *Medical Electricity.*

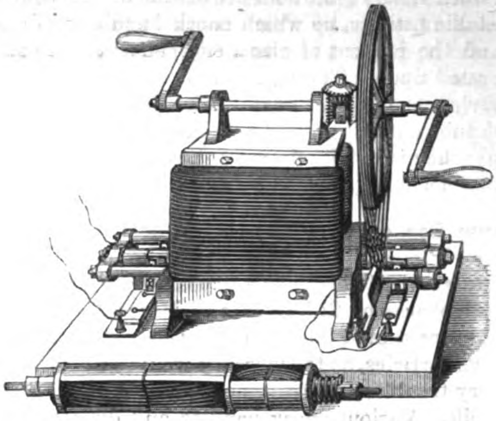


FIG. 2535.

2535 **Dynamo Magneto Electric Machine** (fig. 2535). This machine can be used for a variety of experimental purposes, being an excellent substitute for the Voltaic Battery; it will heat to incandescence 12 inches of Platinum wire, ·01 diameter, or can be arranged to rapidly decompose water. £28 0 0

2536 **Dynamo Magneto Electric Machine** of very large dimensions, for the production of electric currents, equal to sixty cells of Grove's Batteries; an instrument of extraordinary power . . . £138 0 0

Improved modifications of the Dynamo Magnetic Machine are now being constructed, and used in producing the Electric light for Light-house and Marine Service, and also for Illuminating Railway stations, Public Buildings, and Streets; Steam Power being applied for rotating the armatures. It is stated upon reliable authority, that the results to be derived from Dynamo Electrical Machines are always in proportion to the power expended, and the only limit appears to be the rapidity with which the armatures can be rotated.

"Professor Tyndall and Mr. J. Douglas, Chief Engineer of the Trinity House, very recently made some experiments on the comparative action of the different Dynamo Electric Machines of Holmes, Gramme, and Siemens; and Professor Tyndall reports that the new machines, *viz.*, Siemens' and Gramme's, mark a great advance both as to economy and power in the application of the electric light to light-house service. Both inventions undoubtedly place at the disposal of the Elder Brethren of the Trinity House Electric lights of 'surpassing energy.' Mr. J. Douglas recommends the Siemens' machine as being simple in principle and so moderate in cost that a reserve of power can always be maintained without much outlay. By coupling two small machines of Siemens' together, a great augmentation of the light is attainable."

For many years Electro Magnetic apparatus has been used for Electro Plating and Gilding on a very large scale.

Special quotations will be given for these Machines upon application stating requirements.

THE ELECTRIC TELEGRAPH.

TRANSMITTING signals by electrical agency or action would appear to have been suggested and attempted by very many early Electricians. The first investigator in this branch of Science was Stephen Gray, first Copley Medallist of the Royal Society of London, and a Pensioner or Brother in the Charterhouse, between the years 1719 to 1735. Gray's great and original experiment consisted in sending an electrical communication or current along a pack-thread* about 700 ft. long, supported by loops of *silk*, one end of this thread being connected with a Glass Tube; Gray found that upon rubbing this glass tube, the distant end of the thread became instantly electrified, and attracted light bodies. He also found that a metal wire loop did not answer for a support, as the Electricity escaped through it; hence arose his division of bodies into Conductors and Insulators.

In 1747, Mr. William Watson,† an Apothecary and Fellow of the Royal Society, of Aldersgate Street, in the City of London, repeated some experiments that had been made on the Continent, at Berlin and Leipzig, *viz.*, discharging Leyden Flasks through water. These Flasks, modified by the astronomer Dr. Bevis (iron filings having been used inside them in the place of water, and the exterior of the Flask being coated with lead foil), were discharged through and across the Thames, at Westminister Bridge, and at Stoke Newington through a great distance of water in the New River. He also discharged, near Shooters' Hill, Dr. Bevis's jars through nearly two miles of wire, suspended on dried wooden sticks, *the current having to return to the outer covering of the jar through the soil;* but he never had any idea of applying his experiments to telegraphic purposes. In a communication made to the Royal Society in 1746, he says, "Future philosophers may deduce from electrical experiments uses extremely beneficial to society in general."

At Geneva, in 1774, Lesage constructed a telegraph of twenty-four insulated metallic wires that were put into communication with a delicate Pith Ball Electrometer, and caused to be diverged by an Electrical Machine, and produce a signal. In 1794, a German named Reiser contrived a telegraph, the signals being given by electrical discharges sent through interrupted tin-foil spangles placed on glass in the form of letters, as in No. 2214, page 378. In 1795, Cavallo suggested the transmission of signals by exploding detonating substances with the electric current; this was also done in 1787, by Betancourt in Spain. In 1816, Mr. Ronalds, of Hammersmith, constructed a most ingenious Electric Telegraph, consisting of a clock-work lettered and figured dial, used in connection with a Pith Ball Electrometer placed at each station between which it was desired to transmit signals: the electric discharge was passed through a metal wire 525 feet long, enclosed in glass tubes surrounded by wood and pitch. The clocks being constructed to go as near

* Professor Tyndall in his *Notes on Electricity* says *Wire;* Dr. B. W. Richardson, F.R.S., in a Lecture delivered some months back at the Charterhouse, "On the Original Discoveries in Electricity by Stephen Gray," stated *Pack-thread* to have been used. The latter we believe is correct.

† In 1757, Watson received from the German universities of Halle and of Wittenberg a diploma as Doctor. Hence he is in accounts of his previous electrical experiments sometimes called Doctor, though at that time he had not that degree. In 1759, he began—rather late—to apply himself to the study of medicine, and in 1760 he was appointed Physician to the Foundling Hospital in London. A year before his death, which took place in 1787, King George III., before whom as young Prince of Wales he had experimented with his Electrical Machine, conferred on him the order of Knighthood on the occasion of a congratulatory deputation. Thus he died Sir William Watson.—*Dr. Hamel.*

as possible synchronously, at any moment an electric signal could be instantaneously sent through the wire, and the indications on the dial observed at that instant The details of this instrument will be found in the pamphlet published by Ronalds in 1823; but he does not appear to have ever worked through any greater distance than 525 feet. Possibly the following disheartening reply received from the Admiralty Officials upon his submitting his invention, may have deterred him from further experiment—page 24, *Ronalds' Pamphlet*:—

"*That telegraphs of any kind were then wholly unnecessary, and that no other than the one in use would be adopted.*"

In 1819, Oersted made known his remarkable experiment, viz., the deflection of the magnetic needle by a voltaic current (said to have been first discovered by Romagnosi in 1802). Upon this fact are based most of the early forms of telegraphic instruments. There are several continental claimants for the honour of first inventing the Electric Telegraph, but suffice it to say that the first instance of practical out-door telegraphing was made by Mr. William Fothergill Cooke, at the Terminus of the London and Birmingham Railway on July 25th, 1837, the wires being extended from Euston Square to Camden Town, and that in May, 1837, the first Electric Telegraphic Patent was applied for by Messrs. Cooke and Wheatstone as their joint invention.

"The merit of the invention must therefore consist, in a very great degree at least, in the *practical realization* of that which had before been an idea or an experiment," and this practical realization belongs to England.*

From this date improvements and inventions followed rapidly by Cooke, Wheatstone, Henly, Bain, Morse, and very many others, that would require volumes to describe; most interesting particulars of these inventions will be found in the publications of Cooke, Wheatstone, Noad, Lardner, Tyndall, Hamel, and Sabine, &c.

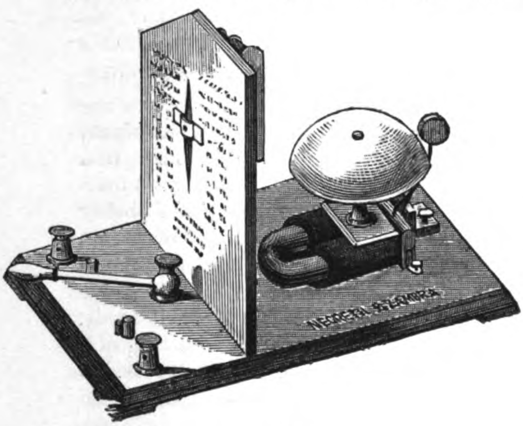


FIG. 2537.

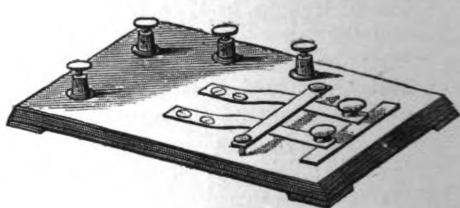


FIG. 2537*.

THE ELECTRIC TELEGRAPH APPARATUS.

2537 **Model Telegraph Instruments,** consisting of two Single Needle Instruments, with Signal Bells and communicators, for exhibiting and explaining telegraphic communication (figs. 2537 and 2537*). These instruments are very carefully constructed, and will be found useful to learners in the art of Telegraphy, or for practical work through short distances of a few miles. The Complete Set of two Needle Instruments with Bells attached £5 10 0

* See opinions of Sir Isambard Brunel and Professor Daniel, given in their award in April, 1841.

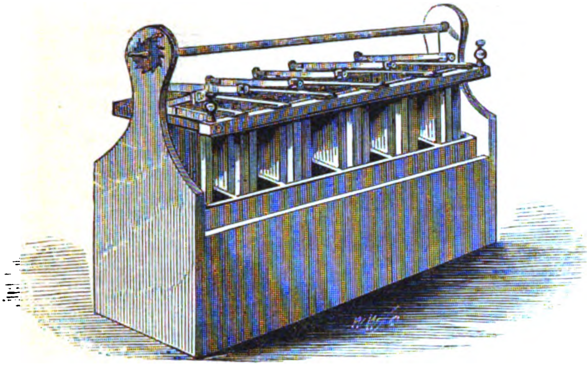


FIG. 2539.

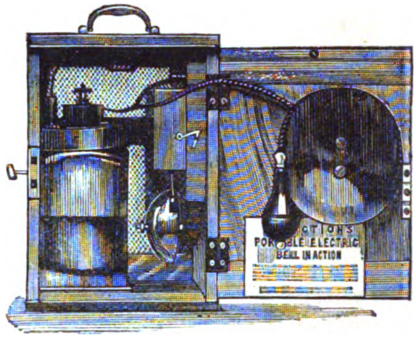


FIG. 2540.

2538 Smee's Batteries for working the above through short distances for experiment, Single Cells . . . . . 8s. 6d. and 10s. 6d. each.

2539 **Six Cell Smee's Batteries** (fig. 2539), for Telegraph use, conveniently arranged in a stout framed tray, with Ratchet Movement for immersing the elements to any desired depth in the acid according to the action required, or for entirely withdrawing them when out of use . . Price £4 10 0

Smee's Batteries when charged with extremely dilute acid will be found to act very well for some considerable time without much attention.

For particulars of Leclanché and other Batteries, see pages 388 to 394.

2540 **Portable Sick Room and Invalid's Electrical Bell and Battery combined,** in a mahogany case, for temporary service. Specially adapted for the use of invalids, with 25 yards of flexible Wire Cord and Presselle, &c. (fig. 2540) £4 4 0

2541 **Electrical Indicating Signal Bell** (fig. 2541). When the alarm is put into action by the electrical current a revolving disc is moved, pointing out to the observer the particular bell that has been sounded: where several bells are in use at a station this is an important addition to the instrument. Price £2 2 0

2542 **Electrical Signal Bells,** as fig. 2542, for suspension on a wall, suited either for Telegraph or Household service.

2½-inch Bell.	3-inch.	3½-inch.	4-inch.
14s.	16s.	24s.	30s.

These Bells can be very economically fitted up in connection with one or more of the Leclanché or Bichromate Bottle Batteries (fig. 2326, page 394). A simple immersion of the elements of the Bichromate Battery in the solution for a second being sufficient to ring a bell to a considerable distance. The Leclanché has, however, been found the most useful form of battery for this work; it being most simple and cleanly in use (no strong or corrosive acid being required), and the elements remain unimpaired for a very long period. See description, page 393.

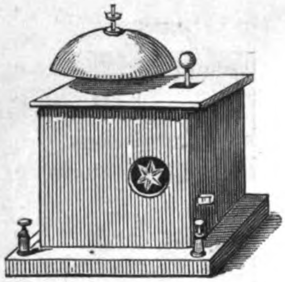


FIG. 2541.

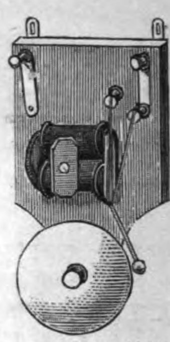


FIG. 2542.

2542* **Electric Colliery Signal Bells,** in Dust Proof Boxes.

Price each 5-inch.	6-inch.	7-inch.	8-inch.
75s.	80s.	96s.	120s.

2542† **Pushes for ringing Colliery Signal Bells,** 18s. 6d. each.

2542‡ **Gutta Percha Insulated Wire,** suitable for Colliery work, various sizes, £9 10s. to £19 10s. per English mile.

2542A **Presselles, Press Buttons or Pushes, and Indicators,** for use with Electric Signal Bells (No. 2542), for household or other purposes, of various forms and patterns. Supplied to order.

ELECTRICAL ALARM THERMOMETERS.

2543 The engraving (fig. 2543) shows the general arrangement of the Alarm Thermometers, designed for regulating the temperature in incubating houses, hot-houses, green-houses, drying stores or rooms, hospital or prison wards, &c. They are also valuable as a fire-alarm, either in large buildings or warehouses or on board of *ship*, and they will notify any change of temperature taking place where the dial A is placed to almost any distance that may be desired.

The construction and action of the Alarm is as follows. At the back of the dial A is fixed a coiled metal spring, in such a manner that it is very sensitive to any changes of temperature, it being lengthened by increased heat, and shortened by cold: these movements are shown by an index in front of the dial A, which has upon it a scale graduated into degrees corresponding to a Thermometer either of Fahrenheit's, Centigrade, or Reaumur, as may be desired. On the glass cover of the dial are mounted two moveable indices, in such a way that they can be turned round to any two points of the divided circle, and there fixed; these two hands represent the highest and lowest temperature required to be notified, the central or moving hand being in connection, by means of a metallic wire, with one pole of a galvanic battery B, and the other two indices being connected by another wire to the other pole of the battery C.

Now, should the temperature of the atmosphere surrounding the dial alter, the central hand will be moved either to the right or left, and the moment it touches either of the outer hands, contact will be made, and the galvanic circuit completed, causing the Bell to ring, and give notice to the watchman that the temperature of the building or vessel has undergone some alteration, and requires attention.

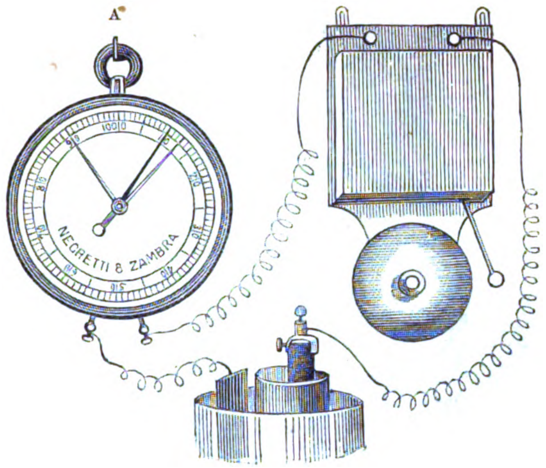


FIG. 2544.

The dial A may be fixed at any distance from the Alarm Bell B, dependent only on the amount of battery power used, one battery being sufficient to work the apparatus between any two portions of an ordinary sized building.

Price of Dial, Alarm Bell, and 1 Battery (fig. 2543) . . £5 5 0

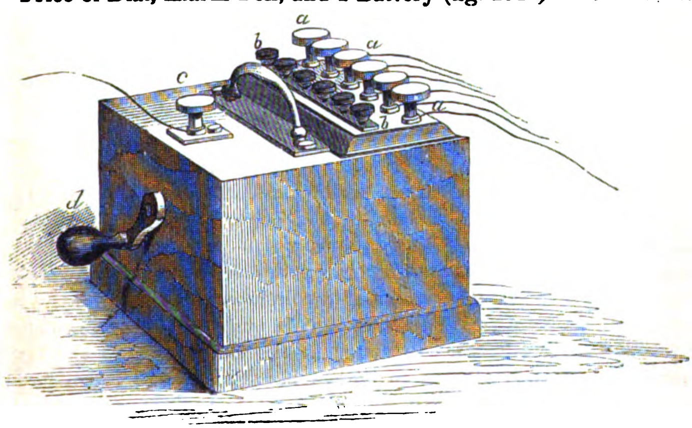


FIG. 2544.

2544 **Magneto Electro Exploder,** improved arrangement, in mahogany case, for firing Mines or Cannon by Electro-Magnetism; price according to the number of charges to be fired (fig. 2544) . . £12 12s. to £26 0 0

2545 **Fuzes,** for use with the Exploder, Experimental, Mining, Blasting, Cannon, and Submarine, supplied to order . . from, per dozen 5s. to 10s.

2546 **Induction Coils,** specially arranged for blasting purposes, where a number of charges are required to be fired simultaneously, in stout case . £13 0 0

2547 **Galvanic Battery,** for use with above 3 16 0

2548 **Copper Wire,** insulated with **Gutta Percha,** for use with above, per 100 yards. Price variable, from £1 1s.

For Prices of Copper Wire covered with Cotton and Silk, see *ante*, page 409.

Estimates given for Telegraph or Household Signal Bells, Electrical Alarm Apparatus, fittings, &c., upon receipt of particulars.

Ordinary form of A B C Telegraph, with Bell (FIG. 2549).

SIR C. WHEATSTONE'S PATENT ALPHABETICAL MAGNETO ELECTRIC TELEGRAPHS.
NEGRETTI AND ZAMBRA, AGENTS.

2548* WHEATSTONE's Instrument is a perfected modification of the *original* Alphabetic Telegraph, invented and patented by him in 1840, the first step-by-step telegraph instrument ever constructed.

Any person able to read is able to manipulate this instrument. The operator has merely to touch in succession, with the fingers of one hand, the keys corresponding with the letters forming the message he wishes to transmit, whilst he turns the handle with the other hand. In order to receive a message the operator has only to watch the letters pointed to by the hand of the indicator. The correspondence can be carried on at about twenty words per minute.

The electric currents which actuate this instrument are produced by the employment of a permanent magnet instead of a voltaic battery; so that chemical preparations are not required, and the instrument is therefore ready to be put in action at any moment, at whatever distant place it may be removed to, and notwithstanding however long it may have been in disuse.

In the absence of voltaic batteries and of working contacts, and in the application of finger keys, consists the essential superiority of these over all the other A B C instruments which have been hitherto introduced.

Fig. 2549 shows the ordinary arrangement for use on private lines.

		Each. £	s.	d.
2549	**Complete Telegraph for one Station,** consisting of Communicator and Indicator	21	0	0
2550	**Alarm Bell,** to work with the above Telegraph	4	0	0
2551	**Communicator separately**	14	0	0
2552	**Indicator separately**	7	0	0

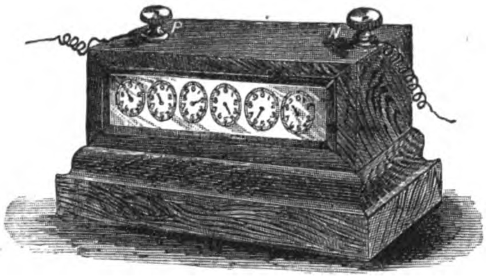


FIG. 2558, Magnetic Counter for Table.

		Each. £ s. d.
2553	**Complete Military Telegraph,** in strong oak or mahogany case, with flush metal fastenings, suited for Field Service (fig. 2553)	22 0 0
2554	**Alarm Bell,** in oak or mahogany case for use with above . .	5 0 0
2555	**Complete Apparatus for the Duplex System,** by which these or other instruments may be worked in opposite directions simultaneously, through a single wire. For the double set . . . . from	5 0 0
2556	**Large Dial Indicators,** for special purposes, from 8 inches to 2 feet in diameter . . . . from	8 0 0
2557	**Switch on Mahogany Slab**	0 10 0

(Fig. 2558) WHEATSTONE'S PATENT MAGNETIC COUNTER.

THIS instrument has been devised for the purpose of counting and registering the periodical movements of any machine, whether rotatory or reciprocating. It may be applied either near to or *at any distance;* it is less cumbrous than mechanical registers, requires no special attention.

No battery is employed, the electric currents being produced by a small armature of soft iron (attached to a moving part of the machine) oscillating before the poles of a permanent magnet. Among the purposes to which this register has been applied are the following:—

1. *To count the number of impressions produced by printing machines.*
2. *To indicate the lengths of cables made by covering machines in telegraph manufactories, or paid out by Cable ships.*
3. *To count the number of revolutions of the screws or paddle-shafts of steamships.*
4. *To count the number of visitors who enter theatres or other public places, &c., &c.*

The Magnetic Counters (fig. 2556°) are made of the following sizes:—

No. 1, to count to	1,000	6 10 0
„ 2,	to indicate in tenths of miles up to 1,000 miles . .	7 0 0
„ 3, to count to	100,000	7 10 0
„ 4, „	1,000,000	8 0 0
„ 5, „	10,000,000	8 10 0
Magnets		2 5 0

The dimensions of the Counter registering to Ten Millions are 10½ inches in length, 3¾ in breadth, and 3¾ in height. The dimensions of the Magnet, fitted in a cast-iron case, are 6 inches long, 3½ broad, and 4 high.

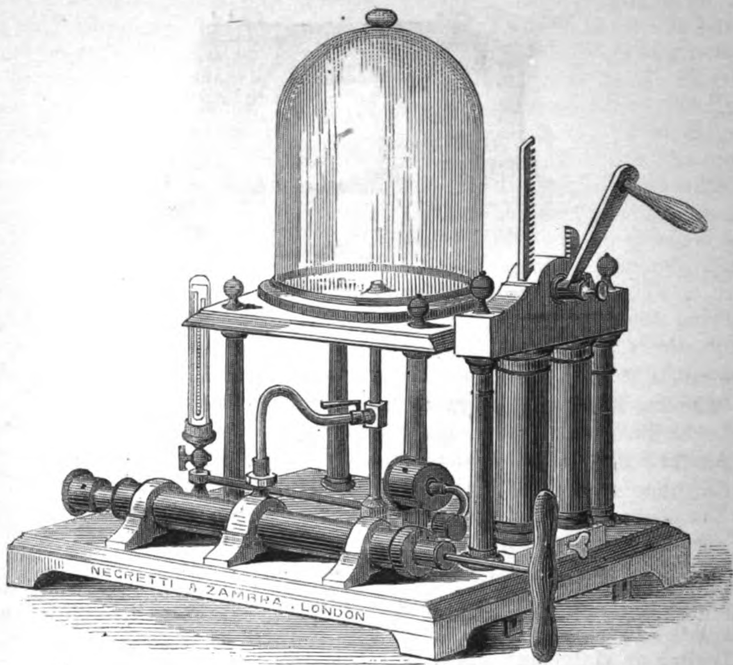


FIG. 2580.

PNEUMATICS, HYDRAULICS, AND HYDROSTATICS.

A DICTIONARY published in 1771 thus defines this branch of science:—

"*Pneumatics*, called also Pneumatology and Pneumatosophy, among scholars the doctrine and contemplation of spirits and spiritual substances." The term *Pneumatics*, as now commonly used, forms that part of natural philosophy which treats of the nature and properties of air and gases.

Hydrodynamics is the science which treats of the motion of fluids, and the application of the principles of this science to the raising and conducting water in pipes; and the construction of all kinds of instruments and machines relating thereto is known by the term *Hydraulics*.

Hydrostatics is the science that treats of the conditions of the equilibrium of fluids, and of the pressure they exert within their own mass or on the sides of any vessel in which they may be contained.

It would appear from history that the ancient Egyptians, Persians, and Chinese were to a certain extent acquainted with the practical application of these sciences in irrigating and draining their lands.

Among the Greeks Aristotle was the first that wrote of the equilibrium of fluids, and reduced the flight of birds, the motion of fishes, and the direction and steerage of ships to the rules of mechanics.

We have already spoken of Archimedes, who came after Aristotle, and discovered the fraud of the goldsmith of King Hiero, of Syracuse. This famous philosopher was the inventor of the Cochlion, or Screw, a machine for raising water to moderate elevations. Ctesibus, of Alexandria, who flourished about 120 years before Christ, by making use of a more complete machine or pump, knew how to raise water to all sorts of heights—this is somewhat uncertain. But of the inventions of the ancients there are none of more striking importance than that of Water Mills, for as described by Vitruvius, they appear to have closely resembled those now commonly in use.

The moderns knew but little of either Hydraulics or Hydrostatics until the time of Galileo, who, holding the same opinion as the ancients that there is no vacuum in nature, attributed the elevation of water by the lift-pump to the abhorrence of a void. From this period these three branches of science, Pneumatics, Hydraulics, and Hydrostatics, so intimately connected, have been studied with great perseverance by Torricelli, Pascal, Abbé Nollet, Des Cartes, Marriotte, Boyle, Papin, and many others, to whose works we must refer our readers for further details.

The inventor of that most important machine the Air Pump was the celebrated scientific Burgomaster of Magdeburgh, Otto von Guericke, who performed several experiments with it at Ratisbon before the Emperor and many persons of distinction in the year 1654. This instrument was very defective, it requiring the labour of two strong men for above two hours to exhaust the air out of glass vessels plunged under water. Some time after Mr. Boyle, with the assistance of Dr. Hook and Mr. Greatorix, contrived a new Air Engine or Pump more commodious and better adapted for experiment than that of the German Burgomaster, and hence the instrument was called Machina Boyleana, and the void space produced by it Vacuum Boyleanum. Several sorts of air pump have been from time to time constructed, and many improvements made in this useful machine at different times, and by different persons.

A curious description of Boyle's Air Pump (which was worked by the feet acting on treadles) will be found in a book published in 1700, entitled, *The Works of the Hon. Robert Boyle, Esq., Epitomized by Richard Boulton, of Brazen-Nose College, Oxford.*

In this work, amongst a number of "New Experiments about the Preservation of Bodies," will be found several "To preserve flesh without Salt included in Receivers in *Vacuo.*"

The writer thus concludes one chapter: "Of what use these Experiments may be for to help Mariners to transport Fresh Meat and Fruits, the Reader may judge." The preserving processes of the present day are mostly based on Boyle's experiment.

The Air Pump now generally in use was constructed and described by Mr. Hawksbee in the year 1709, and afterwards very greatly improved by Davenport, and Benjamin Martin, and the talented engineer Smeaton, who states that with his Air Pump experiments were made in the presence of the Royal Society, Dr. Knight, Mr. Canton, and Mr. Watson, when the air was rarefied or expanded 1,000 times; similar experiments tried with pumps previously in use never exceeded 140 times.

Our engraving (fig. 2580) at the head of this section represents the most improved arrangement of Air Pump yet constructed. With this instrument very large receivers are rapidly exhausted in the usual manner, until the mercury in the gauge falls to $\frac{1}{2}$-inch of the scale, when further exhaustion is obtained by using the Tate's pump placed at the side of the larger cylinders. At a temperature of 60 degrees of Fahrenheit an exhaustion as low as $\frac{1}{10}$th of an inch may be produced, and when the pump is in very perfect action, and the temperature very low, greater exhaustion may be obtained.

PNEUMATIC APPARATUS.

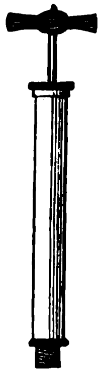


FIG. 2558.

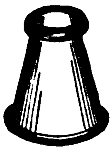


FIG. 2595.

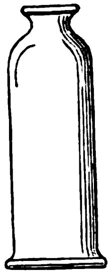


FIG. 2567.

FIG. 2594.

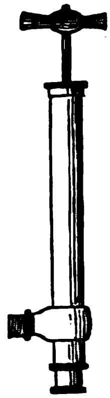


FIG. 2560.

		Each. £ s. d.	Each. £ s. d.
2558*	**Exhausting Syringes** (fig. 2558)	0 8 6	0 10 6
2559	**Condensing Syringes**	0 8 6	0 10 6
2560	**Condensing and Exhausting Syringes,** both in one instrument (fig. 2560)		0 16 0
2561	**Condensing and Exhausting Syringes,** of large size .		1 10 0
2562	**Condensing Pumps,** large, with Metal Valves . .	4 4 0	6 6 0
2563	**Single-Barrel Air Pump,** with Receiver (fig. 2563) .	1 5 0	1 16 0
2564	Ditto ditto larger		2 2 0
2565	Ditto ditto with inclined barrel, raised plate and stopcock (fig. 2565)	2 10 0	3 3 0
2566	**Cylindrical Glass Receivers,** closed at the top for single-barrel air pumps . . . . . . 5s.	0 7 6	0 10 6
2567	**Glass Receivers,** open at top, with ground wolts, as fig. 2567; see also Nos. 2625 to 2631, page 436 . .	0 6 6	0 12 6

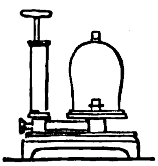


FIG. 2563.

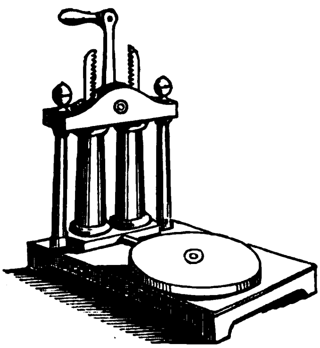


FIG. 2573.

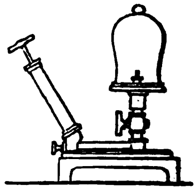


FIG. 2565.

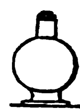


FIG. 2592.

FIG. 2583.

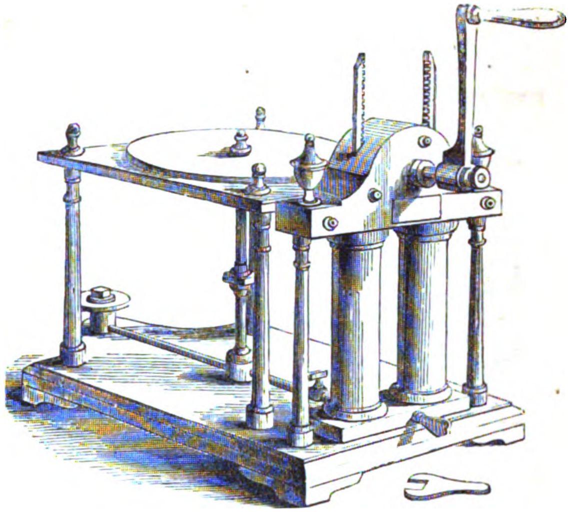


FIG. 2570.

		Each. £ s. d.
2563	**Largest Size Double-Barrel Air Pump,** on strong mahogany stool stand, barometer gauge and cistern, with graduated scale divided to inches and tenths, gun metal ground, receiver plate, 13-inch key and lever	36 0 0
2569	Ditto ditto with 11-inch plate, either of accurately-turned gun metal, or ground plate glass, mounted on a stout mahogany stool stand, with barometer gauge and graduated scale divided to inches and tenths .	25 0 0
2570	**Large Size Double-Barrel Table Air Pump** (fig. 2570), (Davenport's arrangement) with mercurial gauge, raised receiver plate, brass clamp for fastening the pump to the table, and brass spanner . . .	12 12 0
2571	**Double-Barrel Table Air Pump,** second size, ditto .	11 0 0
2572	Ditto, third size, with receiver plate, on stand, with gauge	8 10 0
2573	Ditto ditto without gauge (fig. 2573)	7 10 0
2574	Ditto, fourth size	5 0 0
2575	Ditto, small size	4 0 0
2576	**Newman's Improved Smeaton's Single-Barrel Air Pump,** for obtaining a most perfect exhaustion (*Council Medal awarded,* 1851) large size, with metal valves, and ground glass receiver plate . . .	40 0 0

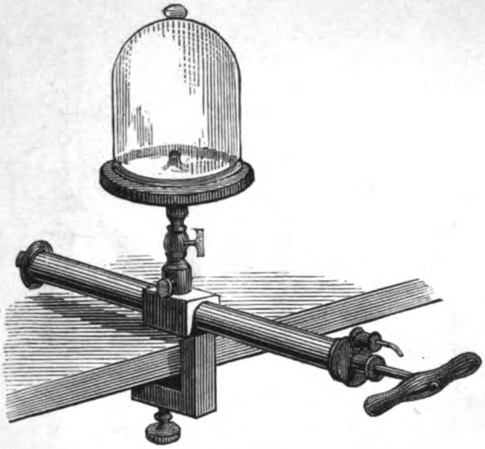


FIG. 2577.

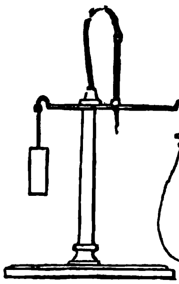
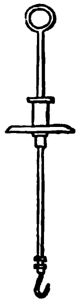
FIG. 2622.

2577 **Tate's Double-Action Air Pump,** having 2 pistons in one cylinder, the air being drawn from the receiver in the middle of the cylinder, and expelled at the two ends. It is mounted on a strong metal clamp and screw, by which it can be firmly attached to any bench or table. The receiver plate is 7 inches diameter, carefully ground; the cylinder is 16 inches long, with $1\frac{1}{4}$-inch bore—length of stroke $8\frac{1}{2}$-inches. The exhausting power of this pump is very great, and it has a very simple contrivance, by which it can be also used for condensing. Its compact form renders this pump one of the most handy and useful for laboratory purposes (fig. 2577).
Price, including syphon gauge and fittings, without the Receiver £4 4 0

2578 **Tate's Double-Action Air Pump,** with larger cylinder, and very firm and strong metal mountings, complete £9 9 0

2579 **Sprengel's Air Pump,** constructed on the principle of converting the space to be exhausted into a Torricellian Vacuum; it may thus briefly be described: If a small hole be made in the top of a barometer tube, the mercury sinks, and draws in air; if the experiment be so arranged as to allow air to enter along with mercury, and the supply of air is limited, while that of the mercury is unlimited, the air will be carried away, and a vacuum produced. The apparatus is chiefly composed of glass tubes, and is of such a nature that it can hardly be offered for sale, but must be arranged to meet the requirements of the operator. It has been much used in preparing Geissler's Vacuum Tubes, and will be found fully described in most modern works on Physical Science. Supplied to Order.

2580 **Double-Barrel Air Pump,** as No. 2580, combined with a Third Cylinder on Tate's principle for obtaining the most perfect exhaustion possible, the large vertical cylinders being used for rapidly exhausting any receiver, and the horizontal cylinder for completing the exhaustion to the most extreme point £17 10 0

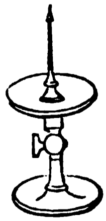
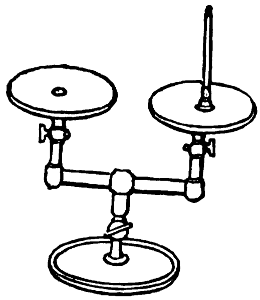



FIG. 2588. FIG. 2584. FIG. 2585. FIG. 2581. FIG. 2582.

		Each. £	s.	d.	Each. £	s.	d.
2581	**Single Transferrer** (fig. 2581)				0	16	0
2582	**Double Transferrer** (fig. 2582)				2	2	0
2583	**Vacuum or Pressure Gauge**, small, for attaching to Pneumatic Apparatus (fig. 2583) (see also Gauges, page 171)	0	5	6	0	7	6
2584	**Flat Brass Plate**, ground for open receivers, with collar of leather and sliding wire (fig. 2584)	0	15	0	1	5	0
2585	**Brass Syringe or Pocket Condenser**, for producing Heat and Light by rapid compression of air within the Brass cylinder (fig. 2585)	0	5	6	0	8	6
2586	**Syringe and Lead Weight**, with ground glass plate for open receiver	0	10	6	0	15	0
2587	**Glass Globe and Stop-cock** (very light), for proving the density or weight of air and gases	0	12	6	0	15	0
2588	**Copper Bottle, Scale Beam and Stand**, with balance weight, for weighing air (fig. 2588)				3	3	0
2589	**Scale Beam and Stand**, fittted with a light **Glass Vessel** graduated in Cubic Inches, by which a number of most instructive experiments can be exhibited, illustrating the specific gravity or weight of various fluids and gases				3	15	0
2590	**Filtering Cup**, with ground Brass Plate, for showing the porosity of wood, without receiver (fig. 2590)	0	7	6	0	12	6
2591	**Fruit or Taper Stand**, for supporting shrivelled fruit, &c., under the receiver of an air pump				0	3	6
2592	**Fountain in Vacuo** (fig. 2592)	0	7	6	0	15	0
2593	**Tall Fountain Glasses**				0	10	6
2594	**Bladder Glass** (fig. 2594)	0	3	6	0	5	0
2595	**Hand Glass** (fig. 2595)	0	2	0	0	4	0
2596	**Bell Experiment**, illustrating that air is essential to sound (fig. 2596)				0	10	6
2597	Ditto, best make, with a ratchet motion (fig. 2597)				1	8	6
2598	**Bell Experiment**, fitted with electro-magnetic break for ringing the bell by galvanic battery				3	0	0

FIG. 2596.

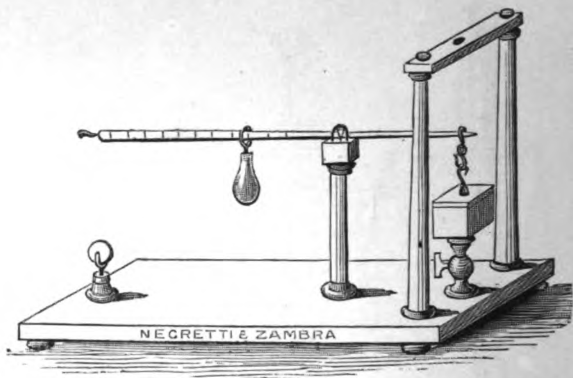


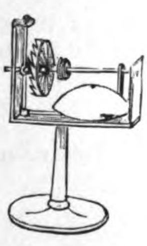
FIG. 2599.

2599 **Apparatus** for demonstrating the pressure of the atmosphere to be about 15 lbs. upon the square inch of surface, an improved form of the Magdeburgh Hemispheres. A brass box, one inch square, is fitted with a ground metal cover, and also a stopcock. When exhausted of air, the cover can be connected to a steelyard, which shows that a force equal to about 15 lbs. is required to remove the cover of the box; mounted on a convenient stand (fig. 2599) £3 10 0

This apparatus is so constructed that the exhausted box can be screwed into the cross bar on top of the upright pillars, and by means of the pulley and cord and a weight, it can be demonstrated that the pressure on the lid of the box is similar in both positions.

No.	Article	Each. £ s. d.		Each. £ s. d.
2600	**Bladder Frame and Lead Weights,** for illustrating the elasticity of the air (fig. 2590)	0 12 0	to	0 16 0
2601	**Lungs' Glass,** for illustrating elasticity of air (fig. 2601)			0 8 6
2602	**Gun-Lock Experiment,** for striking flint and steel *in vacuo*			1 10 0
2603	**Breaking Squares,** of thin glass, to illustrate the pressure and also the expansive power of air			0 1 6
2604	**Wire Cage,** for use with above, to protect the Glass Receiver			0 5 0

FIG. 2601.



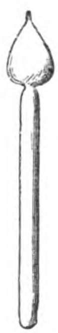


FIG. 2597. FIG. 2605. FIG. 2623. FIG. 2625*. FIG. 2590. FIG. 2600.

FIG. 2609.

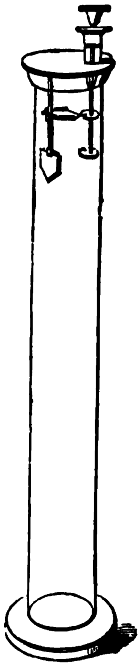


FIG. 2611.

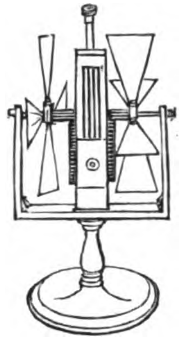


FIG. 2618.

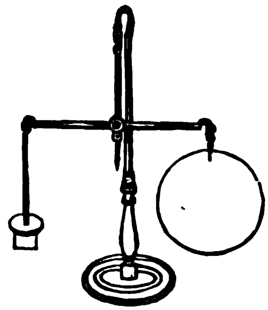


FIG. 2617.

2605 **Magdeburg Hemispheres** (fig. 2605), the invention of Otto de Guericke (1654), for illustrating the pressure of the atmosphere:—
Small, 16s. Second size, 18s. Third size, 30s.

2606 **Torricellian Experiment**, for illustrating the pressure of the atmosphere and construction of the barometer, simple form . 0 15 6

2607 Ditto ditto *larger, with graduated tube*, best mounting and receiver, &c. (fig. 2607) £2 2 0

At pages 2 and 3 will be found a full description of Torricelli's celebrated experiment, and also the construction of Standard Barometers.

		Each. £ s. d.	Each. £ s. d.
2608	**Student's or Laboratory Standard Barometer** . .		5 5 0
2609	**Observatory Standard Barometers**, with mounting board (fig. 2609)	8 8 0	10 10 0
	See also pages 4 and 5.		
2610	**Guinea and Feather Apparatus**, 3 falls		1 10 0
2611	Ditto ditto 2 falls (fig. 2611) without the glass receiver		0 18 6
2612	**Model**, for showing the principle of the common water pump		1 5 0
2613	**Model** for ditto, with glass barrel (fig. 2613), without the stand		1 12 6
2614	**Model of Forcing Pump** (fig. 2614), ditto		2 15 0
2615	**Models of Lifting and Forcing Pumps**, mounted on mahogany stands, with water cistern		5 5 0
2616	**Model** to illustrate the arrangement and construction of Manual Fire Engines		6 6 0
2617	**The Baroscope**, an apparatus consisting of balance beam on a stand, a ball of cork suspended at one end, and a metal weight at the other, illustrating that two bodies balanced in the atmosphere are not so in a vacuum (fig. 2617)		0 15 6

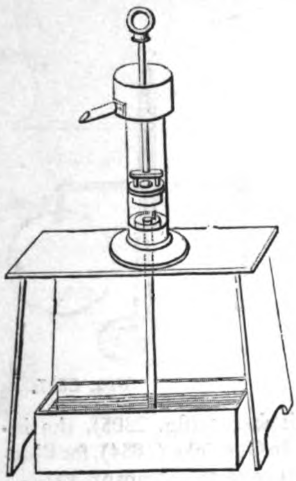


FIG. 2613.

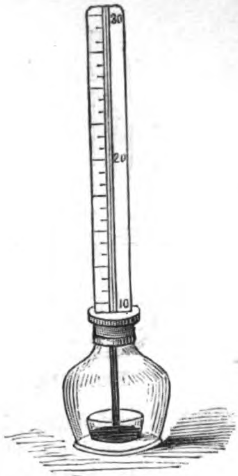


FIG. 2607.

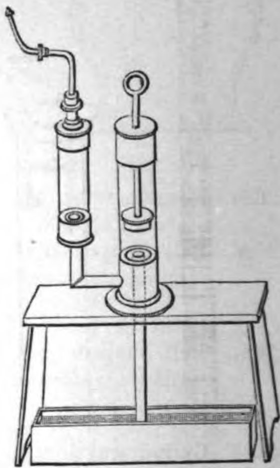


FIG. 2614.

No.		Each. £ s. d.	Each. £ s. d.
2618	**Windmills or Fans,** of a superior construction, with shifting vanes to show the resistance of air (fig. 2618) from		2 2 0
2619	**Four Barometer Tubes,** for showing the upward, downward, oblique, and lateral pressure of the atmosphere		0 10 6
2620	**Leslie's Apparatus for Freezing Water** by evaporation under an exhausted Air-Pump receiver . .		1 10 0

A thin film of ice may be formed by this apparatus in the warmest weather. Leslie's apparatus is the basis of many forms of Ice Producing Machines of the present day. Leslie's Experiment was first made in June, 1810, and is the converse of the experiment, No. 2585, page 432, viz., the production of heat by rapid compression.

No.		Each. £ s. d.	Each. £ s. d.
2621	**Apparatus,** consisting of three glass vessels, for illustrating the mechanical properties of air . . .		0 12 6
2622	**Glass Flask,** mounted with Brass Stopcock, for illustrating the influence of diminished pressure in facilitating ebullition (fig. 2622)	0 12 6	0 15 0
2623	**Philosophical Water Hammer** (fig. 2623), for exhibiting the force and solidity with which water falls in a Vacuum	0 4 6	0 7 6
2623*	**Water Hammer,** V shaped, closed at one end, and having a brass mounting and stop-cock at the other for exhaustion by the Air Pump (fig. 2623*) . .		0 12 6
2624	**Balloons of Gold Beater's Skin,** for filling with Hydrogen Gas . . . . from		0 3 6

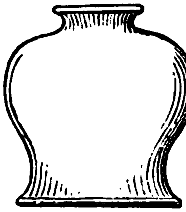


FIG. 2627.

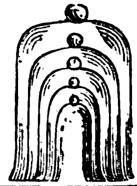


FIG. 2628.

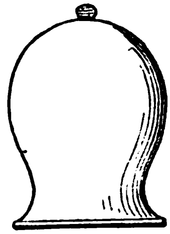


FIG. 2626.

		Each. £ s. d.	Each. £ s. d.
2625	**Receivers for Air Pumps,** well annealed Glass, with accurately ground, welted edges		

2626 **Bell Shaped Close Receivers,** (fig. 2626), diameter across the welt:—

4-in.	5-in.	6-in.	8-in.	10-in.	13-in.
5s.	8s.	10s. 6d.	16s. 6d.	25s.	34s.

2627 **Bell Shaped Open Receivers** (fig. 2627), including ground plate glass cover:—

Diameter	4-in.	5-in.	6-in.	8-in.	10-in.	13-in.
	6s.	9s.	12s.	18s. 6d.	28s.	42s.

2628 **Cylindrical Shaped Receivers, Close** (fig. 2628):—

Diameter	4-in.	5-in.	6-in.	8-in.	10-in.
	4s. 6d.	7s.	8s. 6d.	11s. 6d.	18s.

2629 **Cylindrical Shaped Receivers, Open** (fig. 2629)

Diameter	4-in.	5-in.	6-in.	8-in.
	6s. 6d.	7s. 6d.	12s. 6d.	15s. 6d.

		£ s. d.	£ s. d.
2630	**Tall Cylindrical Glass Receiver, Open** (fig. 2630), for Guinea and Feather experiment	0 16 0	1 10 0
2631	**Tall Glass** for Fountain Experiment	0 12 6	1 1 0
2632	**Air Gun,** of superior manufacture, complete with condensing syringe, bullet mould, &c., in case with lock and key. Made to order. Price		21 0 0

2633	**Mariotte's Apparatus,** arranged to show that under the pressure of two atmospheres air is compressed into half its ordinary volume		1 5 0
2634	**Mariotte's Apparatus,** to exhibit that air expands to twice its ordinary volume under diminished pressure, equal to half an atmosphere.		0 18 6

"Boyle's Law, The law of the compressibility of gases, was discovered by Boyle and Mariotte independently (about the year 1670). In consequence, it is in England commonly called Boyle's law, and on the Continent, Marriotte's Law. This Law is as follows: *The temperature remaining the same, the volume of a given quantity of gas is inversely as the pressure which it bears.* Nos. 2633 and 2634 are constructed for verifying this law.

"In experiment with Mariotte's Tube, as the quantity of air remains the same, its density must obviously increase as its volume diminishes, and *vice versâ*. The law may thus be ennunciated: *For the same temperature the density of a gas is proportional to its pressure.*" Hence as Water is 770 times as heavy as Air, under a pressure of 770 atmospheres, air would be as dense as water.

2635 **Sets of Pneumatic Apparatus,** packed in case, consisting of single or double barrel air pump, open and close receivers, fountain apparatus, pair of hemispheres, sliding wire and collar, syringe and lead weight, bladder, frame, and weight, filter cup and glass for mercury, hand glass and fruit stand . . . . £5 5s.; £10 10s.; £21.

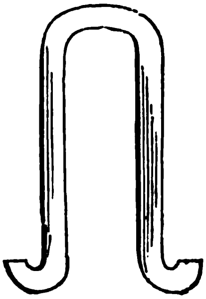


FIG. 2644*.

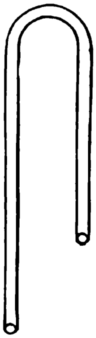


FIG. 2644.

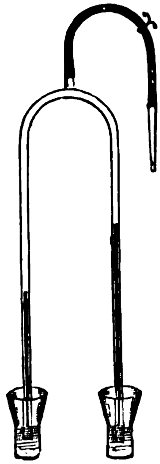


FIG. 2640.

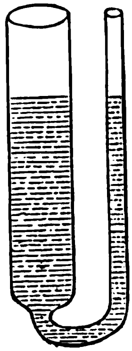


FIG. 2636.


FIG. 2639.


FIG. 2638.

HYDROSTATICS AND HYDRAULICS.

		Each.			Each.		
		£	s.	d.	£	s.	d.
2636	**Hydrostatic Paradox.** An apparatus to prove that a small column of water will support a much larger quantity, and also that fluids will rise and maintain the same level, whatever shape or size the channels through which they flow; **in Glass** (fig. 2636) from	0	2	6	0	5	6
2637	**Hydrostatic Paradox,** large size (fig. 2637), in japanned metal	4	4	0	5	5	0

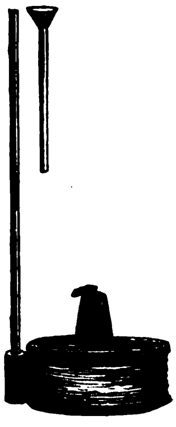


FIG. 2641.

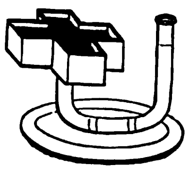


FIG. 2637.


FIG. 2658.


FIG. 2645.

2638 **Hydrometers,** for testing the Specific Gravity of light or heavy fluids, various (see pages 152 to 170) (fig. 2638).

2639 **Gravimeter,** for ascertaining the Specific Gravity of Solids, Stone, Minerals, Precious Stones, &c. (see also No 481, page 165) (fig. 2639).

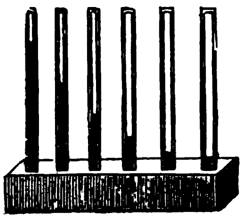


FIG. 2655.

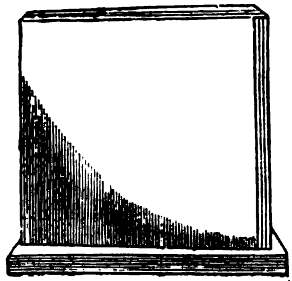


FIG. 2656.

FIG. 2657*.

No.	Article	Each. £ s. d.	Each. £ s. d.
2640	**Boyle's Tube**, for exhibiting the comparative Specific Gravity of two different liquids, or the law that the heights of columns of fluid which counterbalance each other under the ordinary atmospheric pressure are inversely proportional to the density of such fluids (fig. 2640)	0 11 6	
2641	**Hydrostatic Bellows**, to illustrate that fluids press equally in all directions, and the pressure in proportion to the height of the vertical column of fluid (fig. 2641)	2 2 0	4 4 0
2642	**Artificial Fountains**, by Condensed Air, consisting of a Copper vessel, with condensing pump, and a variety of jets for fragrant waters, &c., packed in case from		3 3 0
2643	Extra jets for ditto, of various shapes	0 10 6	0 18 0
2644	**Pewter, Copper, and Glass Syphons**, of various forms (see Chemical section) (figs. 2644, 2644°) . from		0 2 6
2645	**Tantalus Cup**, an illustration of the use of the Syphon (fig. 2645). A small syphon is concealed within the figure, so that water may be poured into the glass vessel until it nearly rises to the mouth, when the syphon commences to act and rapidly draws off the water		0 12 6
2646	**Apparatus** to explain the theory of Intermitting Springs		3 10 0

2646* The Rope Pump of Vera, or Hydraulic Belt. This machine, the use of which has been revived within a few years, is one of the most simple and at the same time efficient of Water Elevators, and yet the most inexplicable in its action. In its ancient form it consisted of a number of hair ropes (for which a band of flannel or felt is now substituted), passing over two rollers, one at the bottom of the well and the other at the top. By means of the upper roller the band is set in very rapid motion, when the water in the well adheres to its surface in a layer, which is thicker the more rapidly the band moves, and becomes nearly half-an-inch thick when the velocity is 1,000 ft. per minute. The water follows the band to any height, and is thrown off by centrifugal force in turning over the upper roller.

2646A **Model of Chain Pump** . . . .

2646B **Persian or Bucket Wheel** . . . .

2646C **Model of Excentric Pump** . . . .

2646D **Model of Water Pressure Engine** . . . . .

Models of Nos. 2646°, and A, B, C, D, constructed to order.

FIG. 2647.

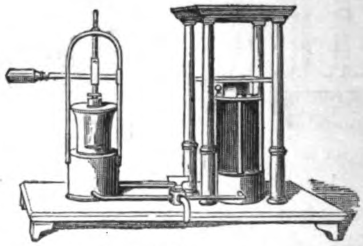


FIG. 2659.

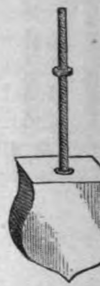


FIG. 2654.

No.	Article	Each. £ s. d.	Each. £ s. d.
2647	**Model of Centrifugal Pump,** for raising water by means of Centrifugal force, combined with Atmospheric pressure (fig. 2647)		5 10 0

Appold's Pump has been most advantageously applied to drainage purposes, very large quantities of water being rapidly and easily raised by it to small heights. It has been found particularly useful for draining marshy or fen land.

This pump was worked on a grand scale at the Exhibition of 1851.

No.	Article	Each. £ s. d.	Each. £ s. d.
2648	**Model of Barker's Mill:** by this machine a rotatory motion is obtained by the centrifugal force of the water employed		3 10 0
2649	**Model of Archimedes' Screw, or Water Snail,** a machine for raising water to small heights requiring little power, with glass tube or worm		5 10 0
2650	**Model of Hero's Fountain,** invented 120 years B.C. .		2 10 0
2651	**Mongolfier's Water Ram:** this machine, by the momentum acquired from the flow of water through a pipe, forces a small column to a considerable height . .		8 8 0
2652	**Apparatus** for illustrating the laws by which fluids Spout through various adjutages	3 3 0	5 5 0
2653	**Apparatus** for showing that more water flows from a short tube than through a simple aperture of equal diameter		1 1 0
2654	**Apparatus** for exhibiting and illustrating the Centre of Buoyancy and Meta-Centre as applied in ship-building (fig. 2654)	1 3 6	1 10 0
2655	**A Series of Six Glass Tubes,** of varying internal diameter, for showing capillary attraction (fig. 2655) .		0 10 6
2656	**Two Plates of Glass,** arranged for showing the hyperbolic curve produced by capillary attraction (fig. 2656)		0 15 6
2657	**Hollow Glass Balloons and Figures, or Cartesian Divers,** for ascending and descending in a tall air-tight vessel of water, as the pressure on the surface is increased or diminished (fig. 2657)		0 2 0
2657*	Ditto In Glass vessel complete (fig. 2657*) . .	0 5 6	0 12 6
2658	**Glass Model of Diving Bell,** with Syringe (fig. 2658) .	1 10 0	3 10 0

		Each. £ s. d.	Each. £ s. d.
2659	**Working Model of Bramah's Hydrostatic Press,** raising 400 lbs., brightly finished, with keys and breaking irons complete (fig. 2659)	10 10 0	18 0 0
2660	**Model of Undershot Wheel**		4 4 0
2661	**Model of Overshot Wheel**		4 4 0
2662	**Model of Breast Wheel**		4 4 0
2663	**Model Canal Lock and Sluice Gates** . . from		10 10 0
2664	**Current Meters,** for showing the Rate or Flow of Tide in a Stream or River, and the amount of gallons per hour delivered (see also page 199, No. 623) . . .	6 6 0	7 7 0

HYDROMETERS, SACCHAROMETERS, GRAVIMETERS, ETC., FOR DETERMINING THE SPECIFIC GRAVITY OF FLUIDS AND SOLIDS (SEE PAGES 152 TO 170).

HYDRAULIC PRESSURE GAUGES (SEE PAGES 179 TO 184).

WATER PRESSURE.

Pounds per Square Inch, at Different Heights.

Height in feet.	Pressure in lbs. per square inch.	Height in feet.	Pressure in lbs. per square inch.
5	2·17	100	43·3
10	4·3	120	51·9
20	8·6	140	60·6
30	12·9	150	65·0
40	17·3	160	69·3
50	21·6	180	77·9
60	25·9	200	86·6
70	30·0	250	108·3
80	34·6	300	129·9
90	38·9		

Each 33 feet vertical height of water equals one atmosphere, or 15 lbs. nearly.

In Sea Water sp. gr. 1·027, the pressure in descending increases at the rate of 280 lbs. upon the square inch for every 100 fathoms, or exactly 1 ton for every 800 fathoms.

ATMOSPHERIC PRESSURE.

Pascal's celebrated experiment was made at Rouen in 1646. He took a tube of nearly 50 feet long, closed at one end, and having filled it with water, placed it vertical with the open end in a vessel of water, and found that a column of water was supported in the tube of 34 feet long, and is 13·6 times higher than the mercury.

Mercury being 13·9 times heavier than water, the weight of this column of water was exactly equal to that of the mercury in Torricelli's experiment, and consequently it was the same force, viz., the pressure of the atmosphere which supported the two fluids.

Assuming that the tube in Pascal's experiment is equal to a square inch in sectional area, and that the height of the mercurial column is 30 inches, this column will contain 30 cubic inches; and as a cubic inch of mercury weighs 3433·5 grains, or 0·49 of a pound, the pressure of this column on a square inch of surface will be found to be 14·7 pounds. The pressure of the atmosphere is in round numbers taken at 15 lbs. on the square inch. The pressure upon a square foot of surface containing 144 square inches is equivalent to 2,160 lbs., or very nearly 1 ton. The surface of a man's body of average size is equal to about 16 square feet; the pressure therefore exerted upon this area 37,560 lbs., or upwards of 16 tons.

Air is 813·67 times lighter than water.

MODELS AND APPARATUS
FOR ILLUSTRATING
THE PHENOMENA OF HEAT, THE STEAM ENGINE, &c.

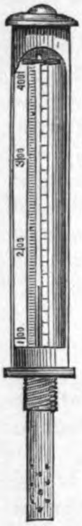


FIG. 2672.


FIG. 2664.

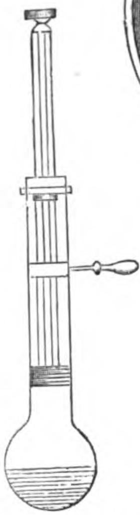


FIG. 2703.

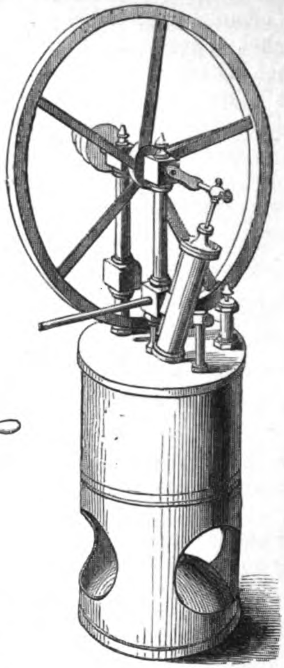


FIG. 2710.

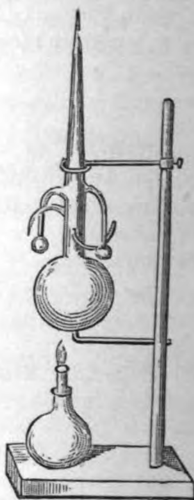


FIG. 2705.

HEAT.

"IN the study of nature two elements come into play, which belong respectively to the world of sense and to the world of thought. We observe a fact, and seek to refer it to its laws; we apprehend the law, and seek to make it good in fact. The one is Theory, and the other is Experiment, which when applied to the ordinary purposes of life becomes Practical Science. Nothing could illustrate more forcibly the wholesome inter-action of these two elements than the history of our present subject, viz., Heat. If the Steam Engine had not been invented, we should assuredly stand below the theoretic level which we now occupy. The achievements of heat through the steam engine have forced, with augmented emphasis, the question upon thinking minds: 'What is this agent, by means of which we can supersede the force of winds and rivers, of horses and men?'

"Heat can produce mechanical force, and mechanical force can produce heat; some common quality must therefore unite this agent and the ordinary forms of mechanical power. The relationship established, the generalising intellect could pass at once to the other energies of the universe, and it now perceives the principle which unites them all. Thus the triumphs of practical skill have promoted the development of philosophy. Thus by the inter-action of thought and fact, of truth conceived and truth executed, we have made our science what it is—the noblest growth of modern times, though as yet but partially appealed to as a source of individual and national might."—*Heat a Mode of Motion*, by JOHN TYNDALL, LL.D., F.R.S., Professor of Natural Philosophy in the Royal Institution of Great Britain.

2664* **Marcet's Apparatus**, for showing the Temperature and Elastic force of High Pressure Steam, and the most important facts connected with Latent Caloric (fig. 2664) . . . . price £4 4 0

Marcet's Apparatus consists of a strong iron boiler, mounted on a tripod stand, with a stout barometer tube of about 33 inches length, and open at both ends, passing through a stuffing box on the top of the boiler to within a short distance of the bottom: attached to the tube is a scale divided into inches and tenths; on one side of this tube is mounted a very accurate thermometer, and on the opposite side is placed a stop-cock, to which can be attached tubes for conducting the steam to any vessel or apparatus for experiment.

When in use, about 8 ounces of mercury are poured into the boiler, which is then half filled with water. By the application of heat the water is boiled with the stop-cock *open*, from which will issue steam, and the temperature indicated by the thermometer will be 212 degrees of Fahrenheit, when the barometer stands at 30 inches. Upon closing this stop-cock the pressure will be increased, and will gradually force the mercury from the bottom of the boiler up the tube, until it marks about 30 inches on the scale, the pressure being equal to one additional atmosphere (15 lbs.), and the temperature marked by the thermometer will be 250° Fahrenheit, showing the relation between pressure and temperature in the formation of steam.*

2665 **Dr. Ure's Steam Apparatus**, for demonstrating the same facts as Marcet's . . . . . price £4 4 0

2666 **Benevides' Steam Apparatus** (fig. 2666), shows a modified form of Marcet's Apparatus, contrived by Professor Benevides, of Lisbon, for exhibiting in a lecture room or to a class the various properties of Steam.

It consists of a strong boiler, B, and on the top of it are three stuffing boxes, *b*, *c*, and *d*, with fittings for a thermometer, a barometer tube, and a mercurial syphon pressure-gauge, all mounted with suitable scales. A model of Giffard's injector, G, is also adapted to the boiler. At A is a stop-cock, for connecting any piece of apparatus to be experimented with.

Among many important facts to be demonstrated by this apparatus is the amount of heat rendered latent when any given quantity of water is converted into steam and other phenomena of latent heat—the laws of ebullition, the influence of pressure over the boiling point of water, the connection between temperature and the elastic force of steam, the production of motion by the elastic force of steam, &c. The action of Giffard's injector is also very prettily illustrated, a small jet of water being easily projected 12 ft. with a good pressure of steam.

Fig. 2666, Price £4 16 6

"It is proved by experiment that the quantity of heat necessary to raise one pound of water one degree of Fahrenheit in temperature is equal to that generated by a pound weight falling from a height of 772 feet against the earth. Conversely, the amount of heat necessary to raise a pound of water one degree of temperature would, if all applied mechanically, be competent to raise a pound weight 772 feet high, or it would raise 772 pounds one foot high. The term '*foot-pound*' has been introduced to express in a convenient way the lifting of one pound to the height of a foot. Thus, the quantity of heat necessary to raise the temperature of a pound of water one degree Fahrenheit, being taken as a standard, 772 foot-pounds constitute what is called *the mechanical equivalent of heat*. If the degrees be Centigrade, 1,390 foot-pounds constitute the equivalent."—*Tyndall.*

* See Dr. A. S. Taylor's table, page 151.

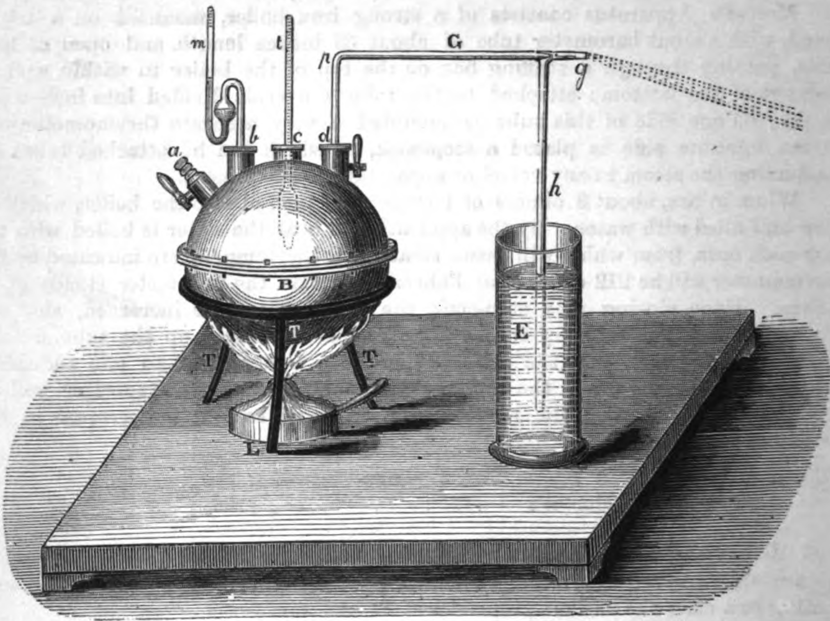


FIG. 2666.

No.	Article	Each. £	s.	d.	Each. £	s.	d.
2667	**Glass Flask,** mounted with brass stop-cock, for experiments with heat under diminished pressure . .				0	10	6
2668	**Cubical Tin Vessel,** with stop-cock, to illustrate the expansion of water into steam by heat and contraction (or condensing) by cooling				0	10	6
2669	**Air Thermometer,** for ascertaining very small differences of temperature by the expansion of air. Invented by an Italian Physician, Santorio, in the seventeenth century (fig. 2669)	0	15	0	1	1	0
2670	**Leslie's Differential Thermometer** (fig. 2670) . .	1	10	0	2	2	0
2671	**Wollaston's Boiling Point Thermometers** (see pages 70 to 72.)						
2671*	**Tyndall's Apparatus,** to demonstrate the production of Heat by friction. See also No. 2752				6	6	0
2672	**Thermometers** (fig. 2672), various, and for High Temperatures, Iron, Brass, or Copper mountings.						

(See page 143.)

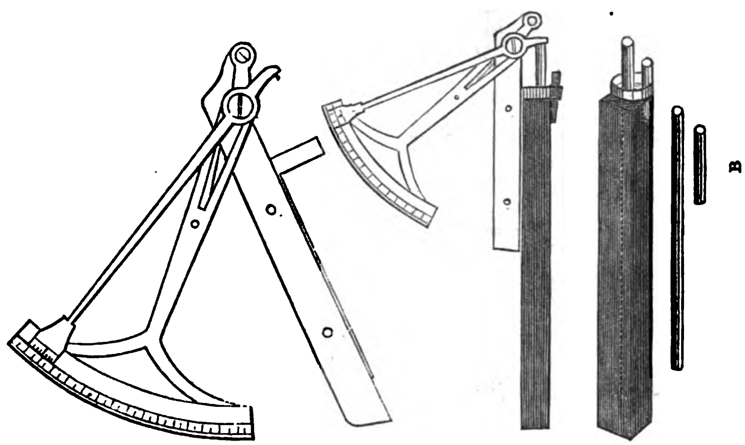


FIG. 2673.

PYROMETERS.

2673 **Pyrometer,** Professor Daniell's, is perhaps the most practically useful; fig. 2673 shows its general arrangement. The indications are obtained from the difference in the expansion by heat of an iron or platinum bar and a tube of well-baked black-lead ware, in which the bar is contained. The metal bar, A, is shorter than the tube, and a short plug of earthenware, B, is placed in the mouth of the tube resting upon the iron bar, and so secured by a strap of platinum and a little wedge that it slides with difficulty in the tube. By the expansion of the metal bar the earthenware plug is pushed outwards, and remains in its new position after the contraction of the metal bar on cooling. The expansion of the metal bar thus obtained is measured off by the instrument and index, C, which traverses over a divided circular scale S before the experiment, and after the earthenware plug has been moved outwards by the expansion of the metal bar B. The degrees marked on the scale are in each instrument compared experimentally with those of the mercurial scale, and the ratio marked on the instrument, so that its degrees are convertible into those of Fahrenheit. (*Philosophical Transactions*, 1830—31.) In use the black-lead cylinder, P, with its metal expansion bar, A, enclosed, is placed into the metal or furnace to be tested, the length of the metal bar being noted on the divided arc, S, previous to the operation, and after its exposure to the heat to be tested. Price £5 5 0

2674 **Ferguson's Pyrometer,** a lecture table instrument, for demonstrating the expansion of metals by heat, the relative amount of expansion of different metals being shown upon the divided Quadrant seen in fig. 2675.
Price, simple form £4 4 0

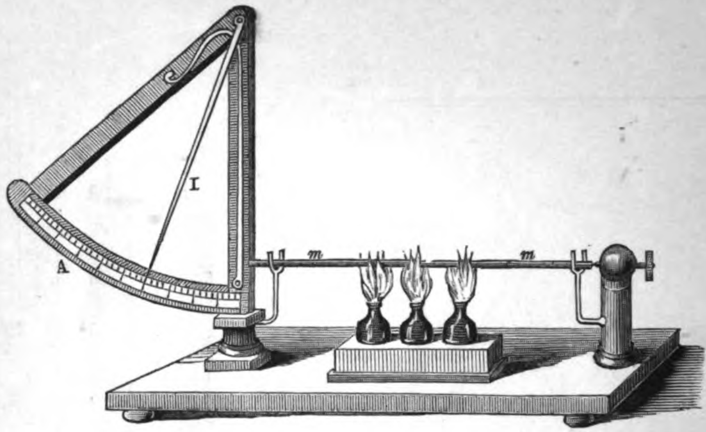


FIG. 2675.

2675 **Furguson's Pyrometer,** in its most complete form, fitted up with an Oil or Water Bath for uniformly heating the metal rods under experiment, the Temperature of the Bath being shown by a delicate Thermometer fitted to it . . . Price, complete with Bath and Thermometer (fig. 2675) £5 10 0

2676 **Wedgewood's Pyrometer:** with this instrument the degree of heat is estimated by the permanent contraction of a prepared Cylinder of Pipe-Clay or Porcelain; but its indications (except for one or two special purposes) are found to be fallacious and of little practical value. Supplied to order.

	Each. £ s. d.	Each. £ s. d.
2677 **Fire Syringe,** for exhibiting the evolution of **Heat** by the rapid Compression of Air. This is the converse of Leslie's experiment (No. 2677), in which Cold is produced by the rapid rarefaction of air . . .	0 5 6	0 8 6
2678 **Metal Bar and Gauge,** for showing, in a simple and conclusive manner, the expansion of metals by heat (fig. 2678)		0 7 6

The Metal Bar when at the ordinary temperature of the air will fit tightly into the gauge; but if it be warmed, the metal will be expanded, and prevent the bar from fitting into the gauge until it is again cooled.

2679 **Metal Ball and Ring,** for exhibiting the same fact .		0 10 6
2680 **Compound Metal Bar,** to exhibit in a striking manner the Expansion and Contraction of metals by heating and cooling. This bar is made of two slips of metal of differing expansibility by heat (Iron and Brass). When Cold this Bar is perfectly straight, but if heated by the flame of a Spirit Lamp it becomes curved . Price, for Bar only	0 6 0	0 8 6
2681 **Compound Metal Bar,** with Stand, large size, for Lecture Table		0 15 0
2682 **Compound Metallic Bar Thermometer** (Brequet's), in the form of a **Watch**		4 4 0
2683 **Apparatus** to show that liquids expand by increase of temperature and become of a lighter specific gravity, consisting of a large glass tube, closed at one end, for holding water, on which floats a small hydrometer adjusted to a temperature of 60°. Upon warming the water over a spirit lamp the hydrometer will sink; but will rise to the surface when the water cools to 60°		0 10 6

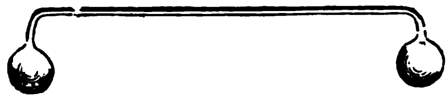


FIG. 2685

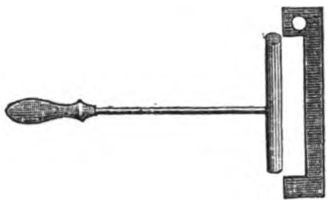


FIG. 2678.

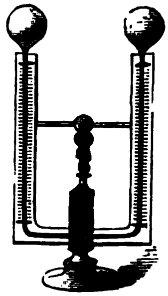


FIG. 2670.

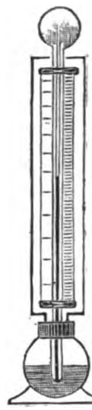


FIG. 2669.

2684 **Apparatus** for showing the varying Expansion of Liquids, and the construction of Thermometers. It consists of five large Thermometer tubes, partly filled with mercury, alcohol, ether, oil, and water; arranged on a stand with tin trough. Graduated scales are fitted to each tube, by which the relative expansion of the liquids in a given time can be observed, when the trough is filled with hot water . Price for Lecture Table size £3 3 0

2685 **Cryophorous, or Frost Bearer** (fig. 2685) (Dr. Wollaston's), is a glass tube with large bulbs at each extremity, as fig. 2685. These bulbs and tube are nearly exhausted of air, and a small portion of water, about half filling one bulb, left in it. If the empty bulb be surrounded with a mixture of pounded ice and snow the rapid evaporation taking place from the surface of the water will cause it quickly to freeze . . . £0 4 6 £0 6 6

2686 **Apparatus** for showing the Conducting power of various metals 0 10 6

2687 **Cylinder** of Wood and Brass, to show Conduction by a strip of paper 0 3 6

2688 **Parabolic Reflectors**, of highly polished zinc, for Experiments on Radiant Heat . . . . per pair 4 4 0 5 5 0

2689 **Stands** for ditto with simple adjustment . per pair 1 4 0

2689* **Stands** for Reflectors, best make, with jointed adjustments (fig. 2689*) . . . . . . per pair 2 12 6

2690 Ditto for . . . . Iron Ball, &c. 0 8 0

2691 **Leslie's Radiator**, or Cube, small size 0 5 6

2692 Ditto ditto larger, with adjusting Stand . . 0 15 0 1 1 0

Leslie's Radiator is a square tin vessel, each of the four side surfaces being different. One is left bright, one roughened, one dull white, and the other black. The vessel being filled with boiling Water the various surfaces will be found by the use of Leslie's Differential Thermometer (No. 2670) to radiate or give off varying amounts of Caloric.

2693 **A Set of Three Leslie's Cubes**, each having inserted a delicate Thermometer for noting the rate of cooling of the liquids in the vessels dependent upon their exterior surfaces. Price, for 3 best mounted Cubes £2 10 0

2693* **Leslie's Pyroscope**, for ascertaining the comparative radiation of various bodies 1 5 6

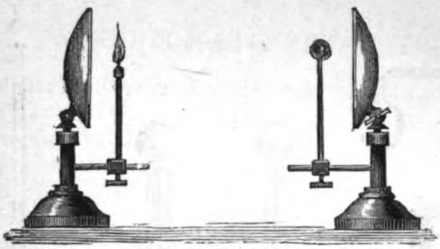


FIG. 2689*.

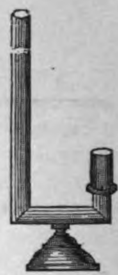


FIG. 2700.

No.	Description	Each. £	s.	d.
2694	**Radiation, Reflection, or Absorption of Heat Apparatus**; consisting of two flat metal discs, having one side blackened and the other bright, with small cups or shelf for holding pieces of Phosphorus. These discs being placed at equal distances from a heated Iron Ball, the Phosphorus will be inflamed on the black surface, whilst that on the bright one will remain unchanged	0	18	6
2695	**Boutigny's Experiment** for exhibiting the spheroidal condition of water when in contact with a strongly heated surface, and also the non-conducting power of vapour	3	3	0
2696	**Silver Bottle and Stopper,** for exhibiting the sudden evolution of steam in Boutigny's experiment . .	2	2	0
2697	**Apparatus** to show the Imperfect Conducting Power of Water, consisting of a sensitive air thermometer, so arranged that Ether can be ignited upon the surface of water surrounding the air bulb, without producing any movement in the thermometer	1	1	0
2698	**U Shaped Glass Tubes,** for illustrating Convection .	0	5	0
2699	**Faraday's Convection Apparatus,** best form, on a stand, for illustrating the mode of heating buildings, &c., by hot water	0	18	0
2700	**Apparatus** to exhibit the principle of **Ventilation,** showing an ascending current of heated air and a descending current of cool air to supply its place (2700)	0	12	6
2701	**Fine Wire Gauze,** for experiments on Flame, demonstrating its inability to pass through a medium formed of Metal Threads, owing to their cooling or conducting power, for explaining the theory and action of Davy's Safety Lamp (No. 244 page 363) 8 inches square	0	2	0
2702	**Glass Apparatus,** for exhibiting the evolution of latent heat by a mixture of two cold fluids. The glass vessel is partly filled with Water, and upon its surface is floated a small light capsule, into which a little piece of dry Phosphorus is placed; now if strong Sulphuric Acid be carefully poured into the water, sufficient heat will be produced to ignite the Phosphorus	0	8	6

Various other experiments illustrating the Phenomena of Heat, see Chemical Section.

THE EARLY HISTORY OF THE STEAM ENGINE.

THE first Steam Engine on record in its most elementary form is that invented and described by Hero* of Alexandria, 120 B.C., in one of his many works entitled, *Spiritalia, seu Pneumatica*. It is simply a spherical vessel or boiler supported on two pivots in such a manner that it will turn freely on its axis. From two opposite sides of the boiler are extended two hollow arms, with a small hole made near the ends, but on one side of each tube. The globe is partly filled with water, which is made to boil violently, when the steam rushing out of these apertures produces a reaction, and the sphere is caused to revolve. Our engraving, No. 2705, is a toy form, in glass, of Hero's Engine, which illustrates its action very prettily.

In the year 1826, in Zack's correspondence, there appeared a communication from Thomas Gonsalez, Director of the Royal Archives of Simanca, giving an account of an experiment reported to have been made in the year 1543 by order of Charles V., in the port of Barcelona. Blasco de Garay, a sea captain, had contrived a machine by which he proposed to propel vessels without oars or sails. Garay concealed the nature of the machine he used; all that was seen during the experiment (made upon a vessel called the *Trinity*, of 200 tons burden) was that it consisted of a great boiler for water, and that wheels were kept in revolution at the side of the vessel; it is reported by one witness that the vessel was moved at the rate of two leagues in three hours. It is rather unfavourable to the claims advanced by the advocates of the Spaniard, that although it is admitted he was rewarded and promoted in consequence of the experiment, yet it does not appear that it was again tried, much less brought into practical use. From the circumstance of the nature of the impelling power having been concealed by the inventor, it is impossible to say in what this machine consisted, or even whether steam exerted any agency whatever.

In 1615 Soloman de Caus, a native of France, published at Frankfort a book entitled, *Les Raisons des Forces Mouvantes, avec diverses Machines tant utiles que plaisantes*, which contains the following theorem: "*Water will mount by the help of fire higher than its level.*" De Caus' machine may be described simply as a stout copper vessel or boiler, which is to be partly filled with water, and partly with air or steam; a tube through which the water is to be raised is fitted to the boiler, reaching nearly to the bottom; upon the application of heat the water in the boiler will be forced up the pipe by the expansion of the confined air, and possibly assisted by the pressure of the steam; a certain portion of the water having thus been elevated, a fresh quantity of water is supplied to the boiler, and the operation repeated. Giovanni Branca, in 1629, published at Rome a work entitled, *Le Machine del G. Branca*, in which is contained a description of a machine moved by a jet of steam. It consists of a wheel furnished with flat vanes upon its rim, like the floats of a paddle wheel. A jet of steam produced under pressure directed against these vanes will cause the wheel to rotate more or less rapidly according to the pressure or force of the steam issuing from the boiler.

Of all the individuals to whom the invention of the Steam Engine has been

* "Ctesibius, an Alexandrine Greek, who lived between the years 150 and 120 before Christ (these dates are given on the authority of Pliny the Elder), was the instructor of the celebrated Hero of history. There were two ancients of this name, both of them writers on mechanical matters. The elder one was the pupil of Ctesibius. The younger Hero is said to have lived seven hundred years later, and wrote on Geometry, Machines used in War, the Defence of Towns, Military Tactics, &c. The elder Hero was the inventor of the first rude form of Steam Engine, and a writer on Pneumatics, on Dioptrics, or the refraction of Light, the raising of heavy weights, and the construction of Automata."

ascribed, the most celebrated and important was the Marquis of Worcester, author of a work named the *Scantling of One Hundred Inventions*, more commonly known by the title, *A Century of Inventions*, published in 1663. By far the greater number of writers and inquirers on this subject ascribe to the Marquis the merit of the discovery of the invention. The contrivance is described in the sixty-eighth invention in the above work: 'I have invented an admirable and forcible way to drive up water by fire, not by drawing or sucking, for that must be as the philosopher terms it, *infra sphæram ativitatis*, which is, but at such a distance. But this way hath no bounder, if the vessels be strong enough." . . "One vessel of water rarefied by fire driveth up forty of cold water, and a man that tends the work has but to turn two cocks, that one vessel of water being consumed another begins to force and refill with cold water, and so successively, the fire being tended and kept constant," &c. These experiments were doubtless made before the publication of the book in 1663. In the contrivance of Lord Worcester the most important item was that the agency of steam was employed in the same manner as it is in the steam engine of the present day, being generated in one vessel, and used for mechanical purposes in another.

In 1683 Sir Samuel Morland proposed to Louis XIV. to raise water by the application of steam. The process appears to have been based on that of Lord Worcester.

In 1695 Denis Papin, a native of Blois, in France, and Professor of Mathematics at Marbourg, made some exceedingly curious experiments in connection with steam power, assisted by water power and the explosion of gunpowder for producing a vacuum, and he finally indicates the use of steam condensed and reconverted into water; but this method of producing a vacuum was previously used by Captain Thomas Savery, to whom a Patent was granted in 1688 for a steam engine to be applied to the raising of water, &c. Savery proposed to combine the machine described by the Marquis of Worcester with an apparatus for raising water by suction into a vacuum produced by the condensation of steam.

Following years brought forth several very important additions and improvements in the Steam Engine by various inventors, viz., Thomas Newcomen, a blacksmith, and John Cawley, a plumber of Dartmouth. The idle but ingenious boy Humphrey Potter contrived to make the engine work its own valves; this was still further improved by Beighton, an engineer. Otto Guericke, Papin, and Smeaton all gave much attention to improving the details of the Atmospheric Engine, which was brought to its high state of perfection by the illustrious James Watt, born at Greenock in 1736, who commenced his experiments on steam in 1763, resulting in the modern Steam Engine, which has immortalised his name in the annals of mechanical science.

The use of High Pressure Steam was first applied to the Steam Engine by Newcomen in 1705, and Leopold about 1720.

From the date of the improvement of Watt until the beginning of the present century High Pressure Engines were altogether neglected in these countries. In 1802 Messrs. Trevithick and Vivian constructed the first High Pressure Engine which was ever brought into practical use in this kingdom.

The first idea of Steam Navigation is to be found in a Patent obtained by Jonathan Mills, 1736. Thomas Paine proposed Steam Navigation in America, 1778. William Patrick Miller patented Paddle Wheels, 1787. Miller and Symington constructed a small Steam Vessel, and successfully propelled it by Steam Power at four miles per hour, 1787. Symington made a passage in a Steamboat built by him, on the Forth and Clyde Canal, 1790; John Fitch propelled a Steamboat with side wheels on the Collect Pond, New York, 1797. First experiment in Steam Navigation on the Thames, 1801. Fulton's Steamboat, *Clermont*, tried on

the Seine, 1803. Fulton worked a Steamboat on the River Hudson, 1807. The *Comet*, built by Henry Bell in 1812, and steamed between Greenock and Glasgow three times a week, carrying passengers at seven-and-a-half miles per hour, 1814, 1815; Steamboats first used on the Thames and Mersey, and in Ireland, 1824. The first ship crossed the Atlantic by the aid of Steam Power in 1819, the *Savannah* from Savannah. Ten thousand pounds given to Captain Johnston upon his making the first Steam voyage to India, 1825. The *Great Western* made her first voyage from Bristol to New York in eighteen days, June, 1838; and the *Great Britain* first sailed from the Mersey, 1845. The *Great Eastern* launched 1857.

Having traced the early history of the Steam Engine to this point, we may now refer our readers to the works of Dr. Lardner and other writers of a more recent date for particulars of the further development and improvement of the Steam Engine, which, as it exists at the present time, is not strictly speaking the exclusive invention of any one individual, it is the result of a series of discoveries and inventions which have been for more than two centuries accumulating.

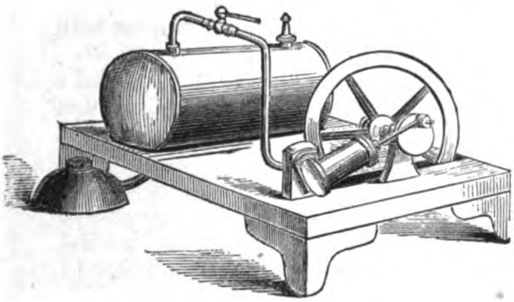


FIG. 2712.

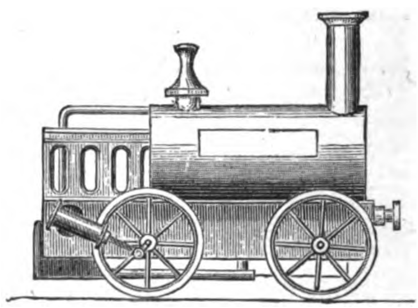


FIG. 2716.

MODEL STEAM ENGINES.

No.	Article	Each. £ s. d.	Each. £ s. d.
2703	**Dr. Wollaston's Apparatus**, showing the production of motion by the generation and condensation of steam (fig. 2703)	0 10 6	0 15 6
2704	**Glass Models of Hero's Rotatory Steam Engine** (Eolipyle), mounted on stand, with Spirit Lamp (fig. 2705)	0 5 6	0 10 6
2705	**Toy Models of Branca's Engine**	0 5 0	0 7 6
2706	**Working Models of Hero's, De Caus', Branca's, Savery's, Papin's, Newcomen's, Hornblower's, and Cartwright's Steam Engines**	made to order.	
2707	**Working Models of Sawing, Rolling, or Grinding Mills, Cranes, Pile Driving Engines, Steam Hammers, Pumps, &c., &c.**	made to order.	
2708	**Working Model of Watt's Low Pressure or Condensing Engine**		21 0 0
2709	**Ditto, Watt's High Pressure ditto** . £5 5 0	10 10 0	15 15 0
2710	**Working Models of High Pressure Oscillating Engine**, with boiler and lamp attached (fig. 2710) £1 1 0	1 5 0	1 10 0
2711	Ditto ditto **larger** and better finished, bright metal		2 10 0

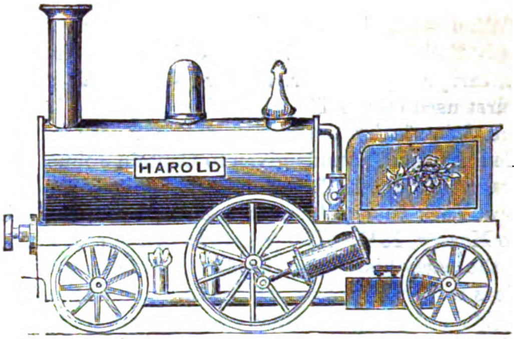


FIG. 2716*.

2712 **Horizontal Steam Engines,** as fig. 2712, with brass boiler, Oscillating Cylinder, steam cock, safety valve, fly wheel, on japanned stand with lamp £1 10 0
2713 Ditto ditto larger, and of higher finish . . £2 2 0 2 10 0
2714 **Horizontal Steam Engine,** with fixed cylinder and slide valve, eccentric motion, boiler, &c., &c., on mahogany stand . . £4 10 0 £5 10 0
2715 **Locomotive Engine, Working Model,** in cheap form, of japanned metal 2 2 0 2 10 0

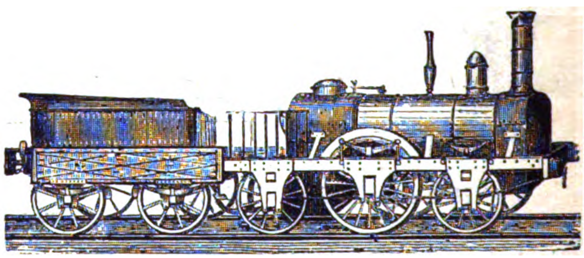


FIG. 2717.

2716 **Locomotive Engines, Working Models,** of superior finish and larger size, of Bright Metal (fig. 2716 and 2716*).
£3 3 0 £4 4 0 £5 5 0 £6 6 0 £8 8 0 £10 10 0
2717 Ditto ditto Six Wheels, with Tender, as fig. 2717 . . 14 14 0
2718 **Working Model Locomotive Engine,** of bright brass, highly finished, with japanned, tender and carriage, and **Circular Railway** (fig. 2718).
£8 10 0 £10 10 0 £12 12 0

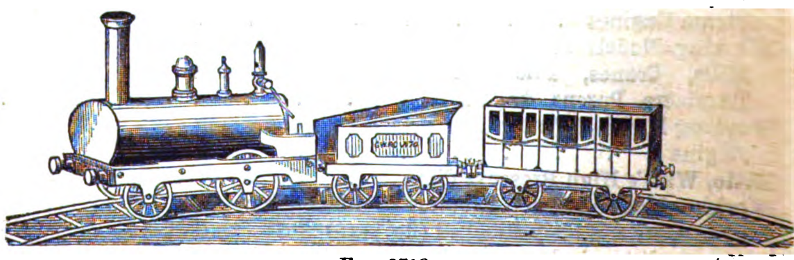


FIG. 2718.

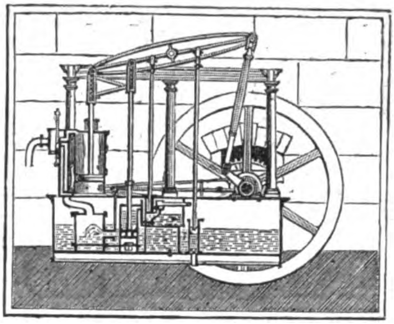


FIG. 2725.

No.	Description	Each. £	s.	d.	Each. £	s.	d.
2719	**Working Model of Steam Fire Engine,** will throw a jet of water a considerable distance				15	15	0
2720	**Working Model of a Marine Beam Engine,** with paddle-wheels, &c.	25	0	0	30	0	0
2721	**Working Model of Penn's Vibrating Engine.** These engines, being simple and compact, are extensively employed in the Thames steam-boats . . from				20	0	0
2722	**Model Steam-Boats,** fitted with working engines and Paddle Wheels, or Screw Propeller . £10 10 0	15	15	0	25	0	0
2723	**Model of Perkins' Steam Gun,** for projecting bullets, with a strong boiler, generating steam at a pressure of 200 lbs. per square inch				14	0	0
2724	**Painted Wooden Sectional Models** of High and Low Pressure Engines and Locomotives, of various constructions, showing the exterior of the engine, and the working of the parts, such as the cylinder, condenser, piston, valves, &c. . . . . from	8	8	0	12	12	0
2725	**Small Sectional Working Model of Condensing Engine,** made of cardboard and metal (fig. 2725)	2	10	0	3	3	0
2726	**Sectional Diagrams and Plans of Steam Engine, &c.,** suited for Lectures, various according to size,	to order.					

MECHANICS AND DYNAMICS.

The Models, &c., detailed in this section will be found valuable aids to the teacher and student in studying the laws of motion and the science of Mechanics.

No.	Description	Each. £	s.	d.	Each. £	s.	d.
2727	**Model Apparatus for exhibiting and illustrating the properties of the Mechanical powers,** viz., levers, simple and compound, pulleys of different kinds, wheel and axle, inclined plane, screw, wedge, capstan, &c., in mahogany and boxwood; in case, with weights complete	5	10	0	8	8	0
2728	**Mechanical Powers,** more highly finished, and complete with Brass pulleys, &c.	10	10	0	21	0	0

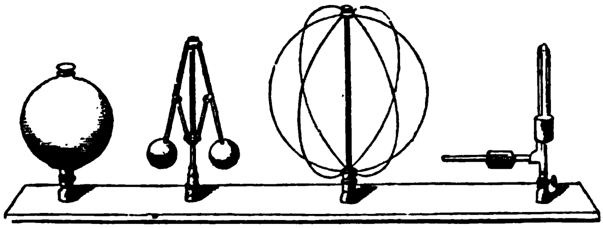
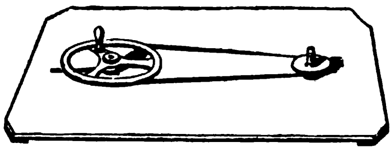


FIG. B.



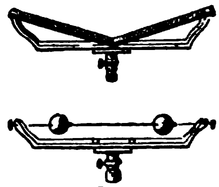


FIG. A. FIG. 2751. FIG. C.

		Each.			Each.		
		£	s.	d.	£	s.	d.
2729	**Sets of Levers,** comprising the three orders, and the bent form				1	10	0
2730	Ditto ditto in Brass				5	5	0
2731	**Systems of Pulleys,** Simple and Compound				2	2	0
2732	**Inclined Plane,** with Carriage and Weights				1	1	0
2733	**Models,** to show the formation of the Screw and Nut, to illustrate the action of screws of different degrees of inclination, the endless screw and compound screws	2	2	0	5	5	0
2734	**Adhesion Plates,** of Glass, with handles				0	15	0
2735	**Inertia Apparatus,** with Brass ball, mounted on a stand	0	15	0	1	10	0
2736	**Apparatus** for showing the impenetrability of matter				0	5	6
2737	**Apparatus** for determining the Centre of Gravity of variously shaped bodies	1	1	0	1	10	0
2738	**Apparatus** illustrating that the stability of a body depends upon the centre of gravity, see also No. 2654				0	12	6
2739	**Double Cone and Inclined Plane,** to show the descent of the centre of gravity, although the cone apparently moves upwards	0	10	6	0	16	0
2740	**Apparatus** for illustrating the Parallelogram of Forces, with weights, &c., complete				6	6	0
2741	**Attwood's Machine** for demonstrating the laws of falling bodies, with pendulum beating seconds, weights, &c., complete on stand, best make				25	0	0
2742	Ditto ditto simple form				12	12	0
2743	**Apparatus** to show that a body takes the same time to descend the diameter or chord of a circle, whatever the length of that chord may be	2	2	0	4	4	0
2744	**Apparatus** to illustrate that the time required for the descent of bodies down an inclined plane is proportionate to its length	2	2	0	5	5	0
2745	**Apparatus** to illustrate the Composition of Force				3	3	0
2746	**Apparatus** to demonstrate that the time required for a falling body to reach the ground is the same, whatever be the force of projection	3	3	0	5	5	0

		Each. £	s.	d.	Each. £	s.	d.
2747	**Apparatus** to illustrate the curve of quickest descent .	2	2	0	3	3	0
2748	Ditto to show the Parabolic Curve described by a projectile				2	2	0
2749	Ditto to illustrate the laws of collision or percussion, with divided arc and ivory balls				3	3	0
2750	Ditto to illustrate the Equilibrium of Forces, complete				6	6	0
2751	**Whirling Table or Centifrugal Machine and Apparatus complete,** for illustrating the laws of Central Forces (fig. 2751, A, B, C.)				21	0	0
2752	**The Whirling Table** only, without apparatus. This can be used for Tyndall's experiment, No. 2671*, page 444, for producing Heat by Mechanical Action or friction				6	6	0
2753	**Model** to illustrate the construction and properties of an Arch				2	2	0
2754	**Model** to show the properties of crown, spur, and bevel wheels, wheel and pinion, and rack and pinion . .				6	6	0
2755	**Model** to demonstrate the properties of Steelyard and Balance	1	1	0	2	2	0
2756	**Model of Capstan or Windlass**	1	10	0	2	2	0
2757	**Glass Models,** for teaching Geometry and Crystallography				2	2	0
2758	**Small Sets of Geometrical Solids and Planes** . .				0	10	6
2759	**Larger Sets of ditto,** with sections of the Cylinder, Cone, and Sphere				1	10	0

The Gyroscope, for description and price see page 458.

LAWS OF FALLING BODIES.

"The *Velocity which is communicated to a body falling freely by Gravity.* Bodies falling freely, near the earth's surface, have communicated to them *equal additions of velocity in equal times;* and since, by the first law of motion, none of these increments of the velocity are lost, but all accumulated in the falling body, it follows that its actual amount at any time must be proportioned to the time during which the body has fallen. If, for instance, a body has fallen through ten seconds, since in each second the attraction of the earth will have communicated to it the same addition of velocity, and since all these additions of velocity will be retained in it, its actual velocity must be ten times that which it would have had after falling one second.

"The velocity which gravity thus communicates to a falling body in *each second of time* near the earth's surface is 32¼ feet, so that, after falling five seconds, its velocity will be five times this amount, after ten seconds ten times this amount; and so on. This velocity is so great, that it would never have been possible to ascertain its amount by direct observations on the fall of heavy bodies.

"Could we, however, by any contrivance, *neutralise* the gravitating tendency of a body to any known amount, reduce it, for instance, to *one-half* or *one-tenth* or *one-hundredth* of what it was, since we should diminish the *velocity* communicated to it in each second precisely to the same amount, we might thus render its motions so slow, that they might be *observed* and *measured;* we might thus find the amount of the additional velocity actually communicated to it in each second, and this multiplied by the known number of times by which we had previously diminished the force of its gravity, would give us the velocity which that fall would communicate in each second when *undiminished.* This is the object of *Attwood's Machine.*" (No. 2741.)—*Illustrations of Mechanics, Moseley.*

EXPERIMENTS TO ILLUSTRATE ACOUSTICS.

		Each. £ s. d.	Each. £ s. d.
2760	**Apparatus** for producing Musical Sounds with a jet of Hydrogen Gas burning in a glass tube, Musical Flames		1 10 0
2761	**Apparatus** for exhibiting a Rotating Singing Flame from		4 16 6
2762	**Trevyllian's Experiment, or Rocking Bar,** for producing sound by the vibrations of a Heated Copper Bar upon a Cold Block of Lead		0 18 0
2763	**Bell Experiment,** for proving sound depends upon the presence of Air (see also Nos. 2596 and 2597) . .	0 15 0	1 10 0
2764	**Improved Arrangement of the Experiment,** with Electro Magnetic Apparatus, for setting the Bell in motion, having a glass receiver, fitted with two stopcocks, for experimenting upon the different gases		4 10 0
2765	**Polarization of Sound,** Apparatus for demonstrating, consisting of a Tuning Fork and Glass Flask . . .		0 10 6
2766	**Monochord,** of simple construction, with adjusting weights, for altering the tension of the vibrating string, for showing the relation and sub-division of musical sounds		6 10 0
2767	**Brook's Apparatus,** to show the relation between the tension of a chord and the time of vibration . .		2 10 0
2768	**Apparatus** for exhibiting the vibration of elastic membranes by sand upon their surfaces (or Chladni's Acoustic Figures)		1 12 0
2769	**Steel Spirals,** for producing various musical sounds, mounted on a sounding board, with a hammer . .		3 0 0
2770	**Syrene,** for ascertaining the number of impulses, in a given time, required to produce any particular note. This is done by a clockwork movement, arranged to record the movement of a disc of metal, perforated with a series of holes, through which a current of air is forced		5 5 0
2771	**Wheatstone's Kaleidophone,** to exhibit the principle of the superposition of small vibrations		1 10 0
2772	**Organ Bellows,** with double riser, wind chest, and sound board, with a set of wood and metal tongued pipes, for producing musical sounds		10 10 0

The Telephone. The price at present asked for these instruments by the patentees and proprietors is so enormous, that Messrs. N. and Z. refrain from quoting for them, hoping that before very long they will be in a position to offer the Telephone for sale at a reasonable rate. It is more than probable that some recent discoveries will entirely supersede the patent instrument. Professor Hughes having already given to the public particulars of some wondrous and most interesting experiments made by himself, with the Microphone and its modifications.

The various Acoustic instruments, &c., invented and used by Messrs. Savart, Wheatstone, Biot, Tyndall, Konig, Helmholtz, Lissajous, Léon, Scott, and others, in their researches connected with Sound, described in Ganot's *Physics*, constructed and supplied *to order*, by Negretti and Zambra.

COLLECTIONS OF MINERALOGY AND GEOLOGY.

MINERALS.

			£ s. d.		£ s. d.
100 Well defined specimen Minerals, in Cabinet			1 10 0	to	3 3 0
200 Ditto	ditto		2 10 0	to	7 7 0
300 Ditto	ditto	larger	7 7 0	to	10 10 0
500 Ditto	ditto	larger	10 10 0	to	50 0 0

All with name and locality, and arranged according to Dana's Mineralogy.

FOSSILS.

100 Fossils, British and Foreign		1 10 0	to	3 10 0
200 Ditto	ditto	2 10 0	to	7 7 0
300 Ditto	ditto	6 6 0	to	10 10 0
500 Ditto	ditto	10 10 0	to	30 0 0
1000 Ditto	ditto	25 0 0	to	60 0 0

Arranged stratigraphically with name, geological position, and locality of each specimen.

ROCKS.

100 Rocks, British and Foreign		1 10 0	to	3 10 0
200 Ditto	ditto	2 10 0	to	7 7 0
300 Ditto	ditto	6 6 0	to	10 10 0
500 Ditto	ditto	10 10 0	to	30 0 0

According to size of Specimens. All with name and locality, and arranged according to Von Cotta.

Collections for special departments of Geology and Mineralogy, Casts of rare Fossils, &c. &c.

All other Instruments, Models, or Apparatus required to illustrate the Sciences for Educational or Lecturing purposes, constructed to order.

FOUCAULT'S EXPERIMENTS WITH THE GYROSCOPE.

M. FOUCAULT, the author of the celebrated pendulum experiment, by which the motion of the earth was made apparent to the eye, read an important paper at the last meeting of the British Association, on "Nouvelles Expériences sur le Mouvement de la Terre au Moyen du Gyroscope." The experiments brought before the Association by M. Foucault on that occasion were of a very striking character, and elicited a request from the Section that they should be repeated before the assembled Association at one of the evening meetings, as they accordingly were. The following illustrated description of the instrument is from the April number of the *Civil Engineer and Architects' Journal.*

"In the accompanying engraving of the gyroscope (fig. 2778), A is a section of the periphery of the wheel, A A, which is constructed with a very heavy rim or periphery, and a light disc, B B, forming the arms by means of which the connection is made to the axis, C C, of the wheel. This axis is hung or connected to a ring, D D, by means of gymbal journals at *a a;* this axis at each end being brought to a conical point and dipping into the conical recess made in the end of the bolts *b;* which bolts being screwed, pass through the brass hoop or ring, and are secured steadily by the jam-nut, *d*, in the position which permits of the free revolution of the axis, C C. This ring, D D, again is hung or connected to the brass ring, E E, by means of gymbal suspensions at *e e*. These gymbal suspensions are constructed in the same way (with bolts and jam-nuts) as those described suspending the axis, C C, of the wheel, A A. Again, this ring, E E, is suspended to the upper part, F F, of the stand, by another pair of gymbals similarly to the others. The box, F F, or upper part of the stand is provided with a prong, G, or long pivot, which dips into a socket on the top of the lower part of the stand, H. The apparatus so made is thus capable of the following motions: The wheel, A A, is capable of revolution on its axis, C C, within the ring, D D;

the ring, D D, including the wheel, A A, is capable of revolution within the ring, E E, round the gymbal suspensions, *e e;* the ring, E E, is again capable of revolution within the box, F F, or upper part of the stand, round the gymbal suspensions that connect it to the frame or stand ; and finally, the whole apparatus is susceptible of revolution horizontally on the pivot, G, which is inserted into the socket of the stand, H."

The same journal then goes on so say : "With the apparatus so constructed, a variety of beautiful experiments can be performed, of which the following are the more interesting. Remove the ring, D D, carrying the wheel, A A, from the machine, set the wheel, A A, in rapid motion, which can be done by winding a piece of twine round the axis of the wheel, A A, and while holding the ring, D D, firmly in the hand, pull the twine violently, so as to uncoil it from the axis, C C ; suspend the ring, D D, by a piece of line attached to itself, or what is better, to the projecting head of the bolt which is outside of the ring at the gymbal journal ; and so long as the velocity of the wheel, A A, exceeds a certain amount, the ring, D D, will stand horizontally, though suspended on one side, or it will remain in any position forming an angle with the horizon in which it may be placed ; and while so suspended will slowly revolve round the suspending twine as a centre of motion. Thus the revolving motion of the mass of the wheel and axis resists the action of gravity on the mass, both of the matter which is in motion and on that which is at rest.

"Another experiment is as follows : Place the ring E E perpendicular, the ring D D at right angles to it ; set the wheel, A A, in rapid motion in the same way as before, and assuming that while the machine is at rest it is in exact equilibrium, suspend while it is in motion a small weight on the projecting head of the bolt, which forms the axis of the wheel, and a horizontal revolution of the whole mass round the pivot centre of the stand will take place. Suspend now a heavier weight at the other end of the axis of the wheel, and the motion will be reversed ; that is, if with the light weight the revolution took place to the right or left hand, it will, after the addition of the heavier weight at the opposite end, revolve to the left or right hand, the directions being determined by the direction in which the wheel, A A, revolves.

"A third very interesting experiment is the following : When the whole machine is at rest, if a stand be slowly turned round on the table, the whole mass will turn with it, the weight of the machine causing sufficient friction on the pivot to produce this effect ; but set the wheel in rapid motion as before, and the stand may be turned either way without disturbing the upper part of the machine, or altering the absolute direction of the axis of rotation. Thus, as with the pendulum experiment, can be shown the actual revolution of the earth, seeing that as the revolution of the earth takes place, it slowly revolves round under the gyroscope, the axis of which retains the same absolute direction in space. Instead of the ring, D D, being used to carry the axis of the wheel, A A, a semi-sphere is sometimes substituted, and in this form if the cup or semi-sphere be carried in the hand, the resis'ance which the moving mass offers to any change in the direction of the axis of rotation opposing any horizontal or perpendicular angular motion in the axis, gives the sensation as if the inanimate matter possessed life and a will of its own."

The following account of the proceedings before the Section of the Association is from the *Athenæum*, No. 1406 :—

"The author spoke in French, but very distinctly, and the apparatus was so simple, beautiful, and exquisitely constructed, that the experiments all succeeded to a miracle, and fully interpreted the author's meaning as he proceeded. The gyroscope is a massive ring of brass connected with a steel axis by a thinner plate of the same metal, all turned beautifully smooth, and most accurately centred and balanced ; in other words, the axis caused to past accurately through the centre of gravity, and to stand truly perpendicular to the plane of rotation of the entire mass. On this axis was a small but stcut pinion, which served when the instrument was placed firmly on the small frame, containing a train of stout clock-work, turned by a handle like a jack, to give it an exceedingly rapid rotatory motion on its axis. But to this clock-work frame it could be attached or detached from it instantly. This revolving mass was only about 3 inches wide, and four of them were mounted in frames a little differently. The first was mounted in a ring, attached to a hollow sheath, which only permitted the axle and the pinion to appear on the outside, so that it could be laid hold of, or grasped firmly in the hand, if the pinion were not touched, while the mass inside was

rapidly revolving without disturbing that motion. By this modification of the gyroscope, the author afforded to the audience a sensible proof of the determination with which a revolving mass endeavours to maintain its own axis of permanent stable rotation; for upon setting it into rapid rotatory motion, and handing it round the room, each person that held it found himself forcibly resisted in any attempt to turn it round either in his fingers, to the right hand or left, or up or down, or in his hands if he swung it round. So that the idea was irresistibly suggested to the mind that there was something living within, which had a will of its own, and which always opposed your will to change its position. The second modification presented the mass suspended in a stout ring, which was furnished with projecting axles, like the ring of the gymbal. These axles could be placed in a small frame of wood bushed with brass. This small frame, when placed on a piece of smooth board, could be turned freely round by turning the piece of board on which it rested as long as the gyroscope was not revolving, friction being sufficient to cause the one to turn with the other; but when the gyroscope was set rapidly revolving, in vain you attempted to turn the frame, by turning the board on which it rested, so determinately did it endeavour to maintain its own plane of rotation, as quite to overpower the friction. In the third modification of the gyroscope it was suspended in gymbals, so exquisitely constructed that both the gyroscope proper and the supporting gymbals were accurately balanced, so as to rest freely when placed in any position in relation to the earth. By this the author showed most strikingly the effect of any attempt to communicate revolving motion round any other axis to a mass already revolving: for, on placing the gymbals in a frame of wood while the gyroscope was not revolving, it remained quite steady; but, when thrown into rapid revolving motion, the slightest attempt to turn the frame round to the right or to the left was instantly followed by the entire gyroscope turning round in the gymbals, so as to bring its axle to coincide with the new axis you endeavoured to give it, with a life-like precision, and always so as to make its own direction of revolution be the same as that of the slightest turn you impart to it. Having thus demonstrated the necessary effect of combining one rotatory motion with another, he then proceeded to demonstrate palpably that the earth's revolving motion affected the gyroscope in precisely a similar way. Having, by the screw adjustments, brought the gyroscope, in gymbals, to a very exact balance, it remained fixed in any position when not revolving. But, rapid rotatory motion having been communicated to the gyroscope mass as soon as the gymbal supports are placed on the stand, you see the entire apparatus, slowly at first, but at length more rapidly, turn itself round, nor ever settle until the axis, on which the gyroscope is revolving, arranges itself parallel to the terrestrial axis, in such a sense as to make the direction of the revolving gyroscope be the same as that of the whole earth. He next showed that the determination with which it did this was sufficient to control the entire weight of the instrument, though that amounted to several pounds: for, taking the ring gyroscope, from the side of the ring of which a small steel wire projected, ending in a hook, the wire coinciding with the prolongation of the axis of the gyroscope; of course, when not made to revolve, the hook, if placed in a little agate cup at the top of a stand, would permit the instrument, by its weight, to fall instantly, as soon as the support of the hand was taken from it. But upon imparting to it rapid rotatory motion, it stood up even beyond the horizontal position, so as to bring its axis of rotation nearly to the same inclination to the horizon as the axis of the earth, while the whole acquired a slow rotatory motion round the point of the hook; and so steady was its equilibrium while moving thus, that a string being passed under the hook and both ends brought together in the hand, the whole may be lifted by the cord off the stand and carried revolving steadily about the room. Next, to show the motion of the earth sensibly, he placed the gymbal gyroscope suspended freely by a fine silk fibre in a stand with the lower steel point of its support resting in an agate cup; a long light pointer projecting from the ring carried a pointed card, which passed over a graduated card arch of a circle placed concentrically with the gyroscope; upon imparting rapid rotatory motion to the gyroscope the index was seen as the earth moved to point out the relative motion of the plane of rotation exactly in the same way: the law of the motion being also the same as that of the well-known pendulum experiment. Lastly, he set the ring gyroscope in motion, and by placing a small, pointed piece of brass at the end of the axle on the ring, the instrument went immediately through all the evolutions of a boy's top on the floor, humming meanwhile loudly also."

FIG. 2773.

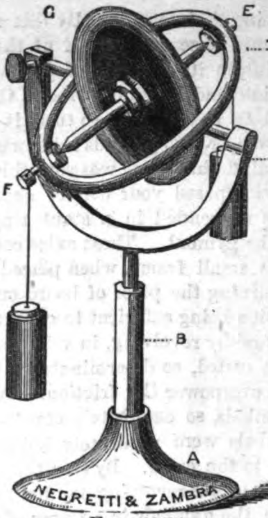


FIG. 2775.

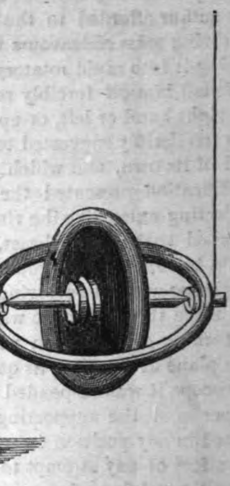


FIG. 2774.

2773 **The Gyroscope,** a modification of Bohnenbergers' machine, introduced by M. Foucault, is an instrument arranged to illustrate the following principles :—

That inertia is a property of matter in motion, as well as of matter at rest.

That orbital and axial motion are intimately related, and that the speed of one may affect or regulate the other.

That the state of unstable equilibrium in which many bodies remain is to be explained by the fact of their rotation.

That bodies in motion endeavour to maintain their original plane of rotation.

That the power of resisting or overcoming the force of gravity possessed by shots fired from Armstrong's gun is due to the gyratory motion given to them by the peculiar formation of the gun.

It will also illustrate the precession of the equinox.

		Each. £ s. d.	Each. £ s. d.
2774	**Gyroscope,** the simple form, with a stand (fig. 2774).		1 10 0
2775	Ditto, of the best and most complete form (as fig. 2775), in mahogany cabinet		3 10 0

Table showing the Tenacity or breaking weight in Pounds for Wires having a sectional area of a Square Millimetre, at a temperature of 60° Fahrenheit.

Cast Steel Drawn	184·36	Tin	6·60
Iron Drawn	140·71	Lead Drawn	5·19
Do. Annealed	110·55	Lead	4·86
Copper Drawn	90·20	Bismuth	2·13
Do. Annealed	69·52	Antimony Cast	1·47
Platinum Drawn	77·00		
Do. Annealed	58·85		
Silver Drawn	63·80	Wood in the direction of the Fibres.	
Do. Annealed	36·08	Boxwood	30·8
Gold Drawn	61·60	Ash	26·4
Do. Annealed	24·20	Fir	19·8
Zinc Drawn	34·58	Beech	17·6
Do. Annealed	31·68	Oak	15·4
Tin Cast	9·15	Mahogany	11·0

At higher temperatures the tenacity rapidly diminishes.

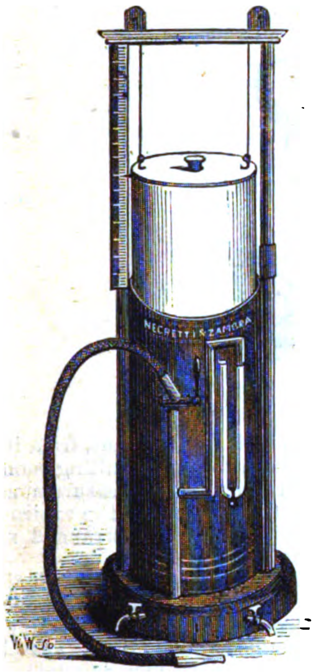


FIG. 2776.

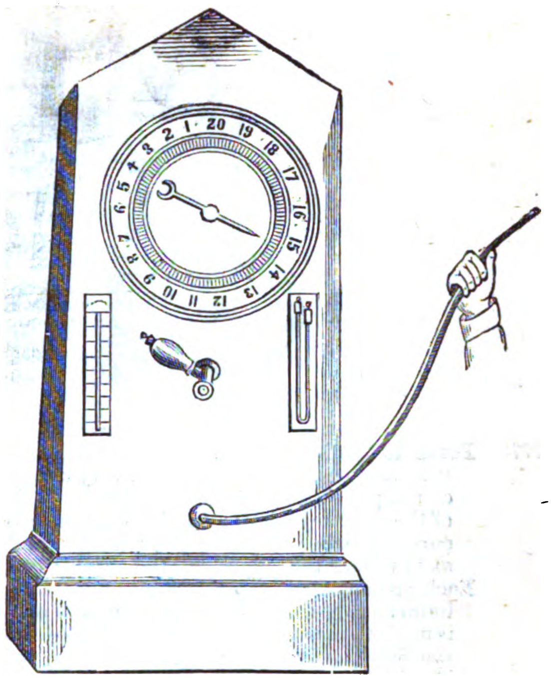


FIG. 2776*.

MEDICAL AND SURGICAL INSTRUMENTS AND APPLIANCES.

		Each. £ s. d.	Each. £ s. d.
2776	**Hutchinson's Spirometer,** for measuring the Vital Capacity of the Lungs (fig. 2776)		4 4 0
2776°	Ditto ditto improved, with **Dial Indicator, &c.** (2776*)	6 6 0	8 8 0
2777	**Measuring and Weighing Machine,** for use with the Spirometer	6 6 0	8 8 0

The object of this instrument is to measure that volume of breath expired from the lungs, which is made by the deepest expiration immediately following the deepest inspiration. It has been determined by actual experiment upon 4,400 males, that this volume (or vital capacity) increases with the stature, quite irrespective of any other measurement upon the human frame. The law is—*For every inch of stature from* 5 *ft. to* 6 *ft., eight additional cubic inches of air, at* 60° *Fahrenheit, is (in the erect position) exhaled from the healthy lungs.* In Consumption this volume is diminished 33 per cent. in the first stage, and 53 per cent. in the second stage of that complaint.

As a man at 5 ft. 8 in. in health breathes 230 cubic inches, and a man in the first stage of Consumption breathes 154 cubic inches, so the healthy condition of the lungs differs from the pthisical lung. All diseases of the Chest diminish the healthy volume of expired air. For particulars see *Medico-Chirurgical Trans.* vol. xxix., p. 137, and *Cyclopædia of Anatomy and Physiology,* Art. THORAX.

FIG. 2778.

2778 **Portable Medical Spirometer, Patent** (fig. 2778). This instrument, from its very small size, will be found a very useful addition to the consulting room of the physician, and to the physiological laboratory. The measurement of the vital capacity is obtained by measuring the velocity of the expired current during the time of expiration, and the instrument is arranged so as to reduce the velocity of the current to Cubic Measure.

Each Spirometer is experimentally Tested by means of a vessel filled with air immersed in water, the cubic contents of this vessel being known; the air is made to pass through the Spirometer at a pressure of six inches of water; the Spirometer is then regulated to show the cubic contents of the vessel. By this means it is found the error of the instrument seldom amounts to more than 2 per cent.

DIRECTIONS FOR USE.—Each instrument is provided with a condenser, which should be placed in a tumbler of cold water; the tube with the mouth-piece must be fixed to the orifice of the condenser, marked "*in*," and the instrument to that marked "*out*." The hands must then be set to zero by turning the milled head, at the same time pressing the spring forward. The patient is directed to take a deep breath, and then to expire steadily through the mouth-piece for as long as possible. The index hands register the number of Cubic Inches of Air expired.

The use of the condenser is to prevent the moist air entering the instrument. After repeated use it is necessary to empty the accumulated water. This is done by disconnecting the instrument and inverting the condenser. Price £4 10 0

HEIGHT.				HEALTH.		CONSUMPTION.		
Ft.	In.	Ft.	In.	Mean.	Minimum.	First Stage.	Second Stage.	Mixed.
5	0 to	5	1	174	146	117	82	99
5	1 —	5	2	182	153	122	86	102
5	2 —	5	3	190	160	127	89	108
5	3 —	5	4	198	166	133	93	113
5	4 —	5	5	206	173	138	97	117
5	5 —	5	6	214	180	143	100	122
5	6 —	5	7	222	187	149	104	127
5	7 —	5	8	230	193	154	108	131
5	8 —	5	9	238	200	159	112	136
5	9 —	5	10	246	207	165	116	140
5	10 —	5	11	254	213	170	119	145
5	11 —	6	0	262	220	176	123	149

Table of the Vital Capacity of the Lungs, compared in Health and in Consumption, at 60° Fahrenheit, upon 5,000 Cases (Male).

No.	Article	Each. £	s.	d.	Each. £	s.	d.
2779	**Vacuum Tubes, or Laryngoscope,** for illuminating the throat				1	1	0
2780	**Jordan's Ear Illuminator**				1	10	0
2781	**Toynbee's set of Silver Specula,** round or oval, with handle				1	1	0
2782	**Speculum Auris**—various forms	0	15	0	1	10	0
2783	**Warden's Auriscope**				0	10	6
2784	**Magnifying Lenses,** for examining Skin Diseases, &c., for the Hand or Pocket, various forms and prices (see pages 254 to 257).						
2785	**Opthalmoscope,** with Lenses complete, in pocket case, the most improved arrangement	1	5	0	2	2	0

NEGRETTI AND ZAMBRA'S CLINICAL THERMOMETERS.

The importance of ascertaining or watching carefully the variations of temperature in disease is daily becoming more apparent. Hitherto one of the main drawbacks to the more general use of the thermometer by practitioners has been the fact that sufficiently portable instruments have not been obtainable. This difficulty is now to a great extent overcome in the Clinical Thermometer devised by Dr. Aitken, and manufactured by Negretti and Zambra. The instrument does not differ from others, perhaps, in accuracy, though it at least equals them, each instrument being tested by a Standard Thermometer, before being issued. Its portability is the great point. The Thermometers are 3, 4, 5, or 6 inches in length, and readily carried in the pocket: they are self-registering, and may be read off at leisure. The important gain is this, that the practitioner may always carry a thermometer about with him; and thus he finds that he has a valuable aid, not only at ordinary, but at many chance times. Useful charts for daily recording the main points in physical Diagnosis have also been published. For prices, descriptive details, see pages 137 and 138.

Kew Certificate to a Clinical Thermometer, extra, 2s.

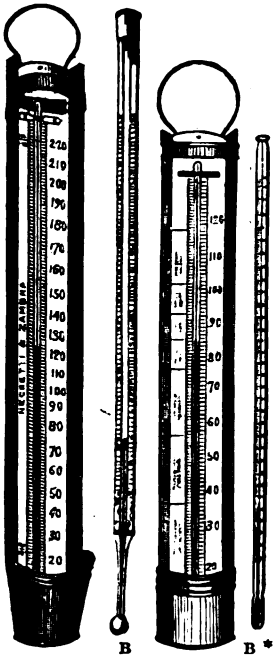
Negretti and Zambra's Clinical Thermometers are usually divided upon their stems with Fahrenheit or Centigrade scales; if both scales are desired upon the same instrument there will be an extra charge of 2s.

2786 **Bath Thermometers,** with Dr. Forbes' specifications, in japanned Metal Cases, 5s. 6d., 6s. 6d. (fig. 2786).

2787 **Chemical and Bath Thermometers,** for particulars of various sizes and prices, see pages 136 and 136, and (figs. A, B, and B*), next page.

2788 **Improved Dropping Bottles** (fig. 2788) for solutions of Nitrate of Silver, Acids, or other Medical Preparations, &c. &c.

These bottles are made entirely from glass tube, the stopper, which is carefully ground in, being formed of stout barometer tube drawn out to a point; over the stopper and neck is fitted a glass cap, also ground so as to be air-tight. The bottle being about two-thirds filled with the fluid to be used, is held in the hand inverted (the cap having been removed), when the warmth of the hand will expand the confined air, and expel the fluid through the perforated stopper, drop by drop. These Dropping Bottles have been found very useful both for Medical, Chemical, and Photographic uses. Price 1s. 6d. each, or in turned wood pocket case, 3s.



A B B*

FIG. 2786.

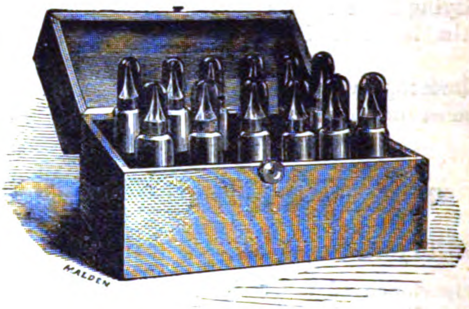


FIG. 2789.

FIG. 2788.

No.	Article	Each £	s.	d.	Each £	s.	d.
2789	**Improved Dropping Bottles,** Set of 12 in case (fig. 2789)				1	5	0
2790	**Stethometer** (Dr. Quain's), for ascertaining the expansion of the chest				1	10	0
2791	**Dentist's Mirrors,** with powerful Magnifier, and hinge-joint, to make them portable . . . . from				1	10	0
2792	**Optometer** (Smee's), for testing the Vision, and arranging lenses to supply any defect				5	5	0
2793	**Eye Shades,** covered with Silk, Black or Green colour .	0	1	0	0	2	0
2794	**Occhiombra or Transparent Eye Shades,** with case .	0	11	0	0	16	0
2795	**Urinometers and Apparatus** connected with their use, see pages 166 and 167.						
2796	**Nitrous Oxide Gas Apparatus,** for Dental operations, complete with pure compressed gas, face-piece, two-way stop-cock, &c., &c.				10	10	0
2797	**Electrical, Galvanic, and Electro-Magnetic Apparatus,** for Medical Use. See pages 415 and 418.						
2798	**Sick Room or Invalid's Telegraph and Signal Bell,** see *ante,* No. 2540, page 423.						

2799 **Galvanic Apparatus,** for supplying a constant current with 32 or 52 Le Clanché Cells.

2800 **Galvanic Batteries,** in series, either Grove's or Bunsen's, arranged for igniting a Platinum Wire of sufficient length for applying **Actual Cautery,** with convenient Directors (*Ecraseurs*) and appliances for Surgical Use, &c., &c. Supplied to order.

Stethoscopes. Enema Apparatus. Breast Pumps, Stomach Pumps, Injecting Apparatus. Pravaz's Hypodermic Syringe. Sphygmograph with improvements. Laryngoscope and Lamps for use with ditto. Cupping Instruments. Spray Producers, Gas Inhalers (various), Respirators. Hearing Trumpets, Voice Conductors or Conversation Tubes. Gas Table Furnaces, and Enamelled Iron Evaporating Dishes for Pharmaceutical purposes, &c., Various forms and prices, with all recent improvements, to order.

MACHINERY FOR THE MANUFACTURE OF SODA WATER AND ALL OTHER KINDS OF

AËRATED AND ARTIFICIAL MINERAL WATERS.

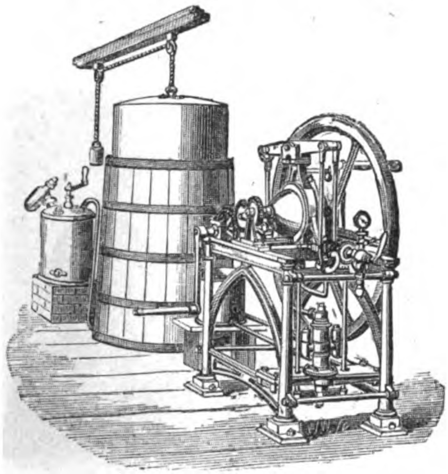


FIG. 2801.

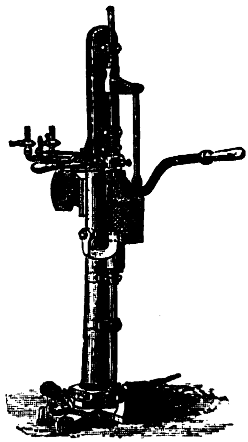


FIG. 2801*.

PATENT CONTINUOUS PROCESS SODA WATER MACHINES.

These "Patent" Soda Water Machines are superior to any hitherto manufactured for solidity of construction, power, and simplicity. They are specially designed for exportation, as they are packed in one case, without taking them to pieces; and can be set to work in an hour after arrival. These Machines are also used to manufacture Ginger Beer, Orangeade, Nectar, Seidlitz, Carrara, &c.

2801 **Soda Water Machine** (fig. 2477). **Producing Power:—**

No. 1, 300 Dozen Bottles per day	£92	0	0
No. 2, 200 „ „	85	0	0
No. 3, 150 „ „	81	0	0
Packing above for Export	5	5	0
Bottling Apparatus	14	0	0
Bottling Machine with Patent Syrup Pump (fig. 2801*)	20	0	0
Dial Indicator	5	5	0

The Soda Water Machines may be driven by Hand or Steam Power; if by the latter, fast and loose Riggers are fixed on the Shaft to Special Order, at an Extra Cost of £2 16s. We advise Foreign Correspondents to utilise vacant space in the Packing Cases by having them filled with *Corks*, thereby saving Freight. No. 1 Machine will take about 300 gross of Corks. Corks or Bottles in any quantity supplied on the most favourable terms.

A supply of *Extra Parts* of *Soda Water Machines* recommended to be sent out with *Export Orders*. Including a Lead Acid Bottle, Lead Pipe Unions and Stop Cock, Caps and Screws for Generator and Acid Bottle, Gland Union Gun Metal Intermediate Wheel, Leather Washers, Cup Leathers, Nipple Ditto, Gun Metal Discharge Valve, Safety Ditto, Valves for Pump, Nipple piece for Lemonade Bottling. Bottling Gloves, Wire Mask, Bottling Shield, Gun Metal Discharge Screw, Set of Leathers for Mouth Piece, Cutting Pliers. £10 15 0

An Illustrated Pamphlet sent with each Machine, containing full instructions for working them, and Recipes for making Soda Water and all Aërated Beverages.

IMPROVED DIVING APPARATUS.

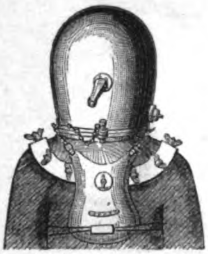


FIG. 2802*.

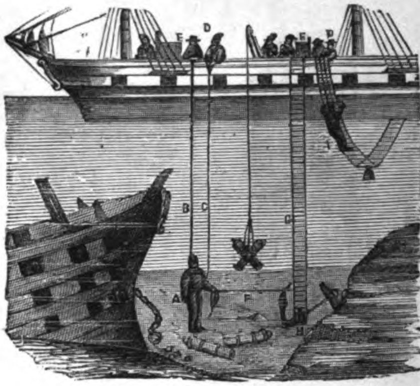


FIG. 2802.

FIG. 2802†.

2802 **Improved Diving Apparatus,** for the recovery of sunken Ships, &c., Building or Repairing Bridges, Pearl fishery, Sponge Diving, or any other Submarine operations. The engraving (fig. 2802) shows the general arrangement of the Diving Apparatus when in use :—

A Diver equipped in Water-tight Dress, Copper Helmet with Glass Eyes, Boots with leaden soles, &c., figs. 2802.
B Tube for supplying Air to the Diver.
C Signal or Life-line.
D Attendants at Signal-line.
E Three-Barrel Atmospheric Air Engine (see also fig. 2803 next page).
F Ladder-line, for use in Thick Water.
G Rope Ladder for Descending and Ascending to and from the vessel.
H Weight to steady the Ladder.
I Diver stopping a Leak under the Water-line.

Anchor, Guns, and Chain Cable to be slung and hoisted up to surface.

By the improvements now introduced, a Diver may remain hours under water without inconvenience.

With each Apparatus there is sent a Book containing a separate illustration and description of every part of the Air-Pump, Tubes, Helmet, Dress, &c.; so that when taken entirely apart, any person can put it together in thorough working order; also full and detailed directions for its use, and how to keep it always in good working order, it being in every respect effective and complete.

Price for Improved Diving Apparatus £140 to £230.

2802A **Sub-marine Lamp** (Denayrowze) large size . . . price £22 0 0
2802B **Ditto** ditto, small size . . . . „ 13 0 0

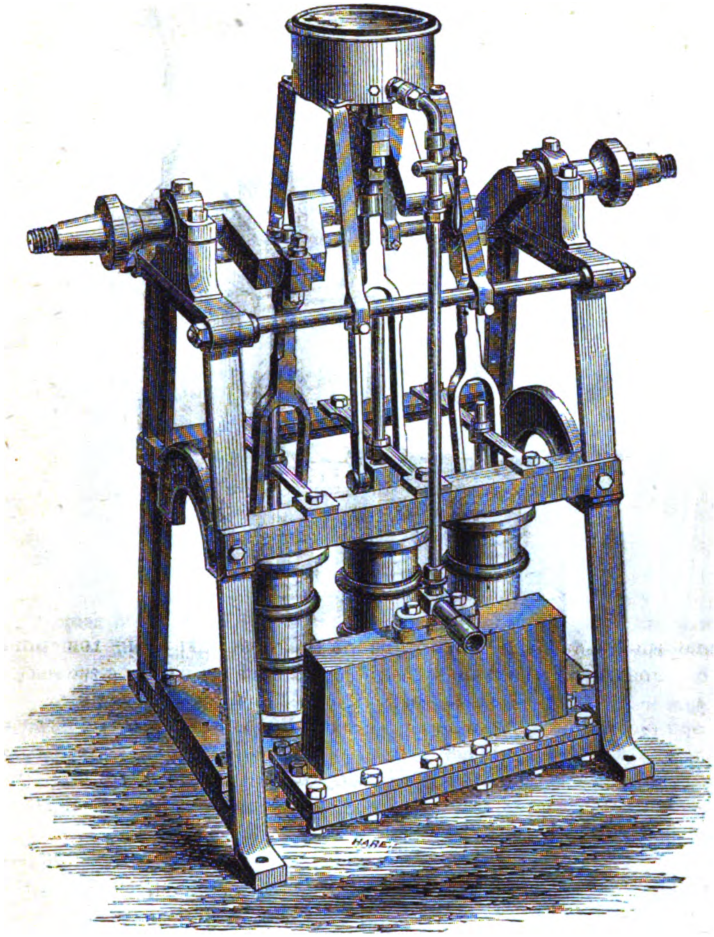


FIG. 2803.

2803 **Treble Barrel Air Pump** (fig. 2803), for the Diving Apparatus, of sufficient power to send down a plentiful and continuous supply of air to the Diver.

A Condensing Chamber.

B Dial Indicator, denoting depth of water and pressure.

The Diving Apparatus consists o a powerful treble-barrel air-engine (fig. 2803), gun-metal cylinders, wrought-iron crank, fly-wheel and handles, spanners, tinned Copper Helmet with segment-screw joint, lead weights, vulcanised tube, metal unions, two diving dresses, suitable warm clothing, boots, signal-line, ladder-line, &c., &c., complete, in strong and secure packages.

This Apparatus possesses the following advantages:—1. Should the Diver wish to raise himself without signalling the attendant, he can do so by simply placing his finger on the valve, which afterwards *rights itself*. 2. Without assistance he can open his own Helmet, which is so constructed that the front eye can *never be lost*, or become tight. 3. The Indicator always denotes the depth the Diver is at. 4. The condensing box secures a more continuous stream of air. 5. It also has a copper cooling cistern, for great depths.

Directions for use, and keeping in repair, sent with each Apparatus.

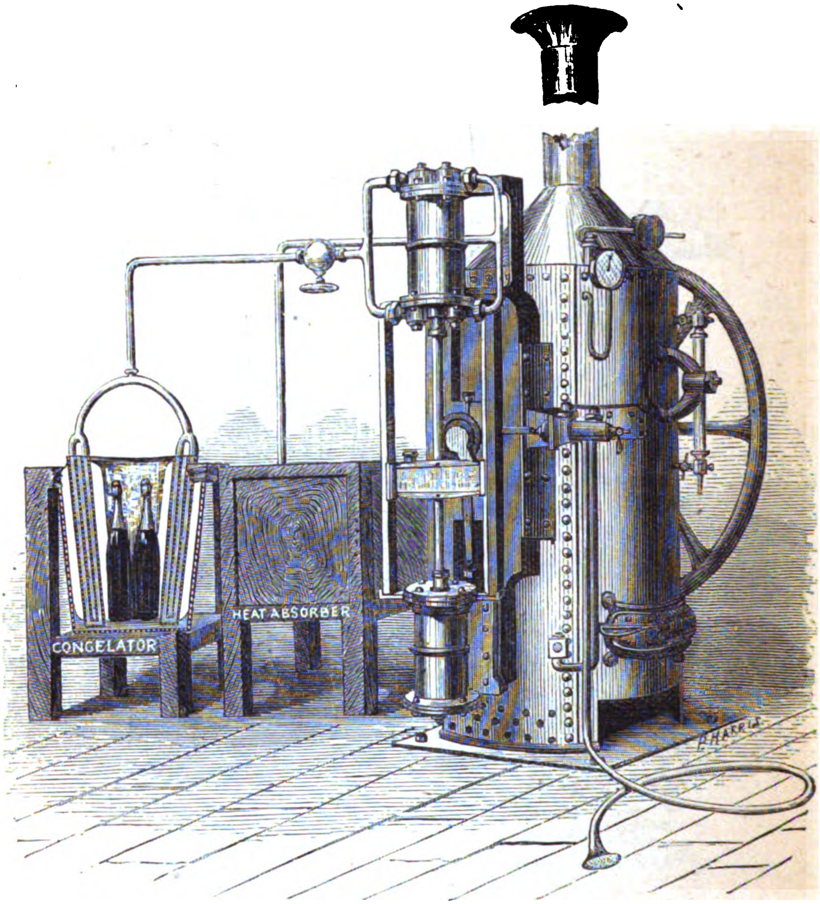


FIG. 2804.

2804 **The Improved Patent Direct-Action Ice-Making Machine,** with Steam Engine and Steam Boiler (fig. 2804). Will also work a Soda Water Machine at same time as making Ice, &c., at an additional cost of £12 for extra long shaft, and fast and loose riggers.

The Ice made by this Apparatus is beautifully clear and crystal, as pure and hard as the best American or Norwegian Ice.

The Congelator or Freezing Chamber is so arranged that it will do either of the following processes under one operation, viz.:—

It will make 25 lbs. of Ice hourly.

Or about 12 lbs. of Ice, and 14 lbs. of Ice Creams hourly.

Or about 12 lbs. of Ice, and cool several bottles of Wine, Lemonade, or Water to nearly the freezing point hourly.

It will cool about 4½ gallons of Drinking Water to nearly the freezing point hourly.

The manner by which congelation is effected is by the production of cold by the evaporation of Æther in a closed vessel, and the continuous employment of the same Æther without appreciable loss.

The construction is reduced to the greatest simplicity, and requires only a few minutes to comprehend. The Boiler is made of the best Staffordshire plate-iron, its strength tested to 120 lbs. upon the square inch, and it is complete with all the usual fittings. No foundations are necessary. The space occupied is about 6½ feet long, 4 feet wide, and 5½ feet high. It is sent out ready for working, with a set of stoking-irons and 6 feet of Iron chimney.

The expense of working the Apparatus is the attendance of one person, and about 10 lbs. of coal hourly or its equivalent in wood fuel. Drawings, with book of reference and instructions, are supplied with each Machine.

	Each. £	s.	d.
Price of the Apparatus, complete, as fig. 2804, delivered in London .	£140	0	0
Packing in strong cases	5	10	0
If with a spare set of fire-bars for Boiler, a supply of ether for continuous freezing, and a few useful duplicates . extra	11	11	0
If the Boiler is arranged for burning wood fuel . . . . extra	4	12	6
Iron Chimney or Bends, for going through a wall, per foot extra	0	6	0
If the Apparatus be made portable by mounting it upon a four-wheel carriage for convenience of land transport . . extra	20	10	0

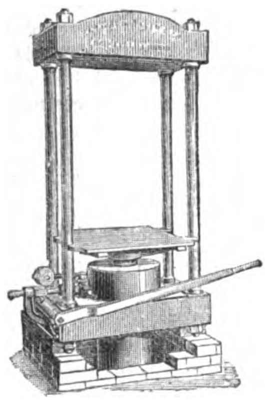


FIG. 2808.

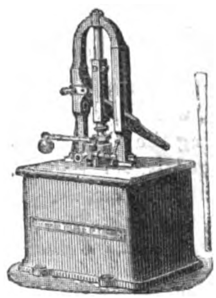


FIG. 2806.

HYDRAULIC MACHINERY.

		Each. £	s.	d.	Each £	s.	d.
2805	**Portable Proving Pumps**, for testing Boilers, Tubes, &c., with discharge Tap and Union, mounted on a strong Iron pail, complete, with Gauge to test to 200 lb. per square inch	7	7	0	8	8	0

2806 **Hydraulic Press Pump** (Bramah Pattern), (fig. 2806). This Pump is fitted with Safety and Relief Valves of the most improved construction, and has been found by experience to be most convenient and durable, and not liable to get out of order under the most severe strains . . . 25 0 0

2807 **Hydraulic Press Pump** of larger and stronger pattern 28 0 0

Extra for knuckle joint, sleeve and pin for working the above Hydraulic Presses by Steam Power, £3 0 0

2808 **Hydraulic Presses**, of various sizes, adapted to different purposes, with Horizontal Pump attached direct to the press. The bed of the press serving for a cistern. These Pumps, as shown in fig. 2808, are provided with relief and safety valves, &c., of the best workmanship.

Price, £36 £50 £80. Power of these Presses 15 to 100 Tons.

HISTORICAL SKETCH OF PHOTOGRAPHY.*

THE Art of Photography, which has now attained such perfection and has become so popular amongst all classes, is one of comparatively recent introduction.

The word Photography means literally "writing by means of Light;" and it includes all processes by which any kind of picture can be obtained by the chemical agency of Light, without reference to the nature of the sensitive surface upon which it acts.

The philosophers of antiquity, although chemical changes due to the influence of Light were continually passing before their eyes, do not appear to have directed their attention to them. Some of the *Alchemists* indeed noticed the fact that a substance termed by them "Horn Silver," which was probably a Chloride of Silver which had undergone fusion, became *blackened* by exposure to Light; but their ideas on such subjects being of the most erroneous nature, nothing resulted from the discovery.

The first philosophical examination of the decomposing action of Light upon compounds containing Silver was made by the illustrious Scheele, no longer than three-quarters of a century ago, viz., in 1777. It was also remarked by him that some of the coloured rays of Light were peculiarly active in promoting the change.

Earliest application of these facts to purposes of Art.—The first attempts to render the blackening of Silver Salts by Light available for artistic purposes were made by Wedgwood and Davy about A.D. 1802. A sheet of white paper or of white leather was saturated with a solution of Nitrate of Silver, and the *shadow* of the figure intended to be copied projected upon it. Under these circumstances the part on which the shadow fell remained white, whilst the surrounding exposed parts gradually darkened under the influence of the sun's rays.

Unfortunately these and similar experiments, which appeared at the outset to promise well, were checked by the experimentalists being unable to discover any means of fixing the pictures, so as to render them indestructible by diffused Light. The unchanged Silver Salt being permitted to remain in the white portions of the paper naturally caused the proofs to blacken in every part, unless carefully preserved in the dark.

Introduction of the Camera Obscura, and other Improvements in Photography.—The "Camera Obscura," or darkened chamber, by means of which a luminous image of an object may be formed, was invented towards the end of the sixteenth century by Baptista Porta, of Padua; but the preparations employed by Wedgewood were not sufficiently sensitive to be easily affected by the subdued light of that instrument.

In the year 1814, however, twelve years subsequent to the publication of Wedgewood's paper, M. Niépce, of Chalons, having directed his attention to the subject, succeeded in perfecting a process in which the Camera could be employed, although the sensibility was still so low that an exposure of some hours was required to produce the effect.

In the process of M. Niépce, which was termed "Heliography," or "sun drawing," the use of the Silver Salts was discarded, and a resinous substance, known as "Bitumen of Judæa," substituted. This resin was smeared on the surface of a metal plate, and exposed to the luminous image. The light in acting upon it so changed its properties, that it became *insoluble* in certain essential oils. Hence, on subsequent treatment with the oleaginous solvent, the *shadows* dissolved away, and the *lights* were represented by the unaltered resin remaining on the plate.

* Hardwich's *Manual of Photographic Chemistry.*

The Discoveries of M. Daguerre.—MM. Niépce and Daguerre appear at one time to have been associated as partners, for the purpose of mutually prosecuting their researches; but it was not until after the death of the former, viz., in 1839, that the process named the Daguerreotype was given to the world. Daguerre was dissatisfied with the slowness of action of the Bitumen sensitive surface, and directed his attention mainly to the use of the Salts of Silver, which are thus again brought before our notice.

Even the earlier specimens of the Daguerreotype, although far inferior to those subsequently produced, possessed a beauty which had not been attained by any Photographs prior to that time.

The sensitive plates of Daguerre were prepared by exposing a silvered tablet to the action of the vapour of *Iodine*, so as to form a layer of Iodide of Silver upon the surface. By a short exposure in the Camera an effect was produced, not visible to the eye, but appearing when the plate was subjected to the vapour of Mercury. This feature, viz., the production of a *latent* image upon Iodide of Silver, with its subsequent development by a chemical re-agent, is one of the first importance. Its discovery at once reduced the time of taking a picture from hours to minutes, and promoted the utility of the Art.

Daguerre also succeeded in *fixing* his proofs, by removal of the unaltered Iodide of Silver from the shadows. The processes employed, however, were imperfect, and the matter was not set at rest until the publication of a paper by Sir John Herschel, on the property possessed by "Hyposulphites" of dissolving the Salts of Silver insoluble in water.

On a means of Multiplying Photographic Impressions, and other Discoveries of Mr. Fox Talbot.—The first communication made to the Royal Society by Mr. Fox Talbot, in January, 1839, included only the preparation of a sensitive paper for copying objects by application. It was directed that the paper should be dipped first in solution of Chloride of Sodium, and then in Nitrate of Silver. By proceeding in this way a white substance termed *Chloride of Silver* is formed, more sensitive to light than the Nitrate of Silver originally employed by Wedgewood and Davy. The object is laid in contact with the prepared paper, and, being exposed to light, a copy is obtained, which is *Negative,—id est*, with the light and shade reversed. A second sheet of paper is then prepared, and the first, or Negative impression, laid upon it, so as to allow the sun's light to pass through the transparent parts. Under these circumstances, when the Negative is raised, a natural representation of the object is found below; the tints having been again reversed by the second operation.

This production of a Negative Photograph, from which any number of Positive copies may be obtained, is a cardinal point in Mr. Talbot's invention, and one of great importance.

The patent issued for the process named *Talbotype* or *Calotype* dates from February, 1841.* A sheet of paper is first coated with Iodide of Silver by soaking it alternately in Iodide of Potassium and Nitrate of Silver; it is then washed with solution of Gallic Acid, containing Nitrate of Silver (sometimes termed *Gallo-Nitrate of Silver*), by which the sensibility to light is greatly augmented. An exposure in the Camera of some seconds or minutes, according to the brightness of the light, impresses an invisible image, which is brought out by treating the plate with a fresh portion of the mixture of Gallic Acid and Nitrate of Silver employed in exciting.

* In April, 1839, the Rev. J. B. Reade made a sensitive paper by using an infusion of Galls after Nitrate of Silver. By this process Mr. Reade obtained several drawings of Microscopic objects by the Solar Microscope. The paper was used wet. In a communication to Mr. Brayley, of the London Institution, Mr. Reade proposed the use of Gallate or Tannate of Silver, and Mr. Brayley in his public lectures in April and May explained Mr. Reade's process. R. W.

On the use of Glass Plates to retain sensitive Films.—The principal defects in the Calotype process are attributable to the coarse and irregular structure of the fibre of paper, even when manufactured with the greatest care, and expressly for Photographic purposes. In consequence of this, the same amount of exquisite definition and sharpness of outline as that resulting from the use of metal plates, cannot be obtained.

We are indebted to Sir John Herschel for the first employment of glass plates to receive sensitive Photographic films.

The Iodide of Silver may be retained upon the glass by means of a layer of Albumen or white of egg, as proposed by M. Niépce de Saint-Victor, nephew to the original discover of the same name.

A more important improvement still was the employment of "Collodion" for a similar purpose.

Collodion is an ethereal solution of a substance almost identical with Gun-cotton. On evaporation it leaves a transparent layer, resembling goldbeater's skin, which adheres to the glass with some tenacity. M. Le Grey of Paris* originally suggested that this substance might perhaps be rendered available in Photography; but our own countryman, the late Mr. Archer, was the first to carry out the idea practically. In a communication to the *Chemist* in the autumn of 1851, this gentleman gave a description of the Collodion process much as it now stands; at the same time proposing the substitution of *Pyro*-gallic Acid for the Gallic Acid previously employed in developing the image.

At that period no idea could have been entertained of the stimulus which this discovery would render to the progress of the Art; but experience has now abundantly demonstrated, that, as far as all qualities most desirable in a Photographic process are concerned, none at present known can excel, or perhaps equal, the Collodion process.

PHOTOMETERS FOR TESTING ILLUMINATING POWER OF COAL GAS.

		Each. £	s.	d.
2809	**Bunsen's Photometer**, for comparing and measuring the illuminating power of coal gas, and for testing the comparative value of various gas-burners	3	3	0
2810	**Dr. Letheby's 60-inch Photometer**, mahogany standards, gas pillar, with double cock, micrometer adjustment, slide for candle, wooden shades, &c.	8	8	0
2811	**Evans' Standard Photometer**, 100-inch scale, in polished pine case lined with black velvet, with disc frame, central adjustment, slide ventilators, velvet canopy, &c., &c.	17	17	0
2812	**Experimental Meter**, 144 cubic inches capacity, combination index, minute clock and gas index working on one dial, 5 feet hourly rate of consumption, and time circle, small circles showing 5 feet actual consumption, and 10 minutes. The minute clock with lever escapement dead beat provided with bell, which is struck every minute	12	12	0
2813	**Sight-hole Beam**, on brass cross-piece pillar, with brass chains and weights, scale for weighing two candles in candle holders whilst burning, grain weights 500 to ¼-grain, mounted on mahogany board	5	0	0
2814	**King's Pressure Gauge**, to show 100th part of an inch pressure £3 3s.	4	4	0
2815	**Specific Gravity Apparatus**, for testing the gravity of Coal or other gases, consisting of a light glass flask of one Cubic Foot capacity, mounted with a Stop-cock and also a suitable balance and grain weights, one grain being equivalent to 1·728 cubic inches of air	3	3	

FOR GAS PRESSURE GAUGES, GAS TESTING THERMOMETERS, GRADUATED TUBES, SPECIFIC GRAVITY FLASKS, HYDROMETERS, &c., &c., SEE PAGES 153, 173, 339, 342, AND 349.

* *Traite Pratique de Photographie sur Papier et sur Verre:* Gustave Le Grey; Paris, June, 1850. Translated by W. Cousens, and published in London, August, 1850. R. W.

PHOTOGRAPHIC APPARATUS.

1851. PRIZE MEDAL awarded to NEGRETTI AND ZAMBRA.

1855. Honourable Mention, Paris.————The Austrian Gold Medal.

1862.

TWO PRIZE MEDALS,

For many important

Inventions and Improvements.

1875. A Prize Medal, Santiago, Chili.——1876. Three Prize Medals, Philadelphia.

NEGRETTI AND ZAMBRA'S PHOTOGRAPHIC LENSES.

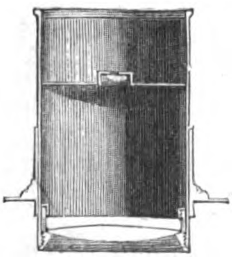


FIG. 2816*.

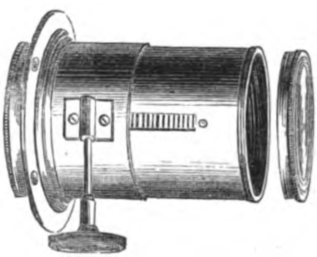


FIG. 2816†.

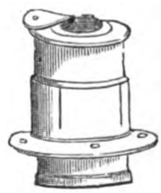


FIG. 2816.

LANDSCAPE LENSES,

2816 **Single Achromatic Lenses,** mounted in Brass, with a flange, of the best quality, for taking Views, copying inanimate objects, statues, prints, &c., where time is not important, but sharpness of detail absolutely necessary (figs. 2816):

2817 **Single Achromatic Lenses:**

	Diameter.	For Pictures.	Simple sliding Tube (fig. 2816). Each. £	s.	d.	Rack & Pinion (fig. 2816†). Each. £	s.	d.
No. 1	2-in.	6-in. by 5-in.	1	12	0	2	2	0
No. 2	2¼-in.	7-in. by 6-in.	1	15	0	2	7	0
No. 3	2¾-in.	9-in. by 7-in.	2	5	0	2	14	6
No. 4	3-in.	11-in. by 9-in.	3	15	0	4	10	0
No. 5	3½-in.	12-in. by 10-in.	4	12	6	6	0	0
No. 6	4-in.	15-in. by 12-in.	6	10	0	7	7	0
No. 7	1¼-in.	**Stereoscopic size**	1	8	0	2	0	0

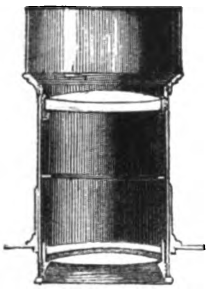


FIG. 2818B.

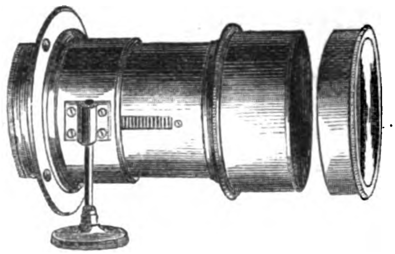


FIG. 2818.

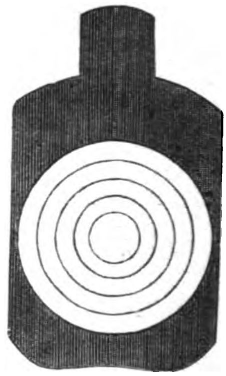


FIG. 2818A.

COMPOUND ACHROMATIC LENSES FOR PORTRAITS.

2818 **Combination Achromatic Lenses** (fig. 2818), mounted in Brass front, with Rack-work adjustment, and adapted for either Portraits or Views, fitted with set of Waterhouse's Central Diaphragms (fig. 2818A). Fig. 2818B is a sectional view of the Portrait Combination Lens, showing the relative position of the different Lenses.

		£	s.	d.
No. 1	4¼-in. by 3¼-in.	2	15	0
No. 2	Arranged for Views, 6-in. by 5-in., and Portraits 4¼-in. by 3¼-in.	3	3	0
No. 3	5-in. by 4-in.	4	4	0
No. 4	Arranged for Views, 7-in. by 6-in. and Portraits 5-in. by 4-in.	4	10	0
No. 5	6-in. by 5-in.	5	10	0
No. 6	Arranged for Views, 9-in. by 7-in., and Portraits 6-in. by 5-in., **Cabinet Size**	6	6	0
No. 7	8½-in. by 6½-in.	11	16	0
No. 8	Arranged for Views, 12-in. by 10-in., and Portraits 8½-in. by 6½-in.	12	12	0

The arrangement of the above Lenses for **Views** consists in the removal of one lens in the combination, and placing the other in a different position in the sliding tube, with the requisite stops or diaphragms for regulating the amount of light. The back pair of lenses are to be entirely removed, and the *front* combination screwed into its place, the *plano* side of the lens to be *outwards* towards the object to be photographed.

2819 **Carte de Visite Combination Lenses, for Portraits, with Waterhouse Stops,** suitable for a room 16 to 18 feet long 4 4 0

2820 **Stereoscopic Combination Lenses for Portraits and Views,** fitted with Waterhouse's Stops, in pairs, with adjusting bar for caps of lenses, warranted of equal foci . . . . per pair, 5 12 6

These lenses are also suitable for taking Carte de Visite pictures in an operating room of ordinary length, say from 12 to 14 feet.

Messrs. Negretti and Zambra, in quoting the prices of their lenses, guarantee them to possess the essential qualities for producing perfect pictures—the chemical and optical rays coincident—flatness of field—rapidity of action. A specimen photograph may be had from each lens, if required, without any extra charge.

For the convenience of their customers, Negretti and Zambra supply Lenses of other makers at the same prices as the manufacturers.

DALLMEYER'S PHOTOGRAPHIC LENSES.

DALLMEYER'S "EXTRA" QUICK-ACTING PORTRAIT LENSES.

Especially constructed for Portraits of Children, but generally useful also for Vignettes, Cartes de Visite, Locket Portraits, &c.

		£	s.	d.
2821	**No. 2 C.* Portrait Lens,** with rack and pinion movement; the lenses 2¾ in. diameter and 4½ in. focal length from the back glass; for pictures on plates 4¼ by 3¼ and under. With a Set of Waterhouse Diaphragms, in case	15	15	0
2822	**No. 3 C. Portrait Lens,** 3½ in. diameter, 6 in. back focus, with rack and pinion, &c., as above, for pictures, 5 by 4, and under	26	5	0

These lenses produce pictures in about one-half the time of No. 1 *B, and No.* 2 *B respectively, but the field of view is not so flat.*

2823	**Miniature Lens,** ditto ditto; the lenses 1¼ in. and 1⅜ in. diameter respectively, and 2 in. focus from the back glass; for pictures on plates 2 in. by 2 in., with a Set of Diaphragms	5	15	0
2824	**Medallion Lens.** Diameter of combinations ⅝ in., back focus 1 in., in a rigid mount, without stops	2	10	0

QUICK-ACTING PORTRAIT LENSES,

ESPECIALLY CONSTRUCTED FOR CARTE DE VISITE PORTRAITS.

"*A Set of Waterhouse Diaphragms in case,*" quoted *separately* in former editions of catalogue, has been *added* to the prices of the several lenses, the *total cost* in each case remaining the same.

2825	**No. 1 B Carte de Visite Lens,** with rack and pinion movement, the lenses 2 in. diameter and 4½ in. back focus, for Portraits, 4¼ by 3¼ with a Set of Waterhouse Diaphragms, in case	6	5	0
2826	**No. 1 B [Long],** with rack and pinion movement, the lenses 2¼ in. diameter, and 4¾ in. back focus, with a set of Waterhouse Diaphragms	6	15	0

This Lens is constructed to meet the requirements of photographers who desire to use a longer focus Lens than No. 1 *B, but who have not sufficient length of gallery for No.* 2 *B.*

2827	**No. 2 B Carte de Visite Lens,** with rack and pinion movement, the lenses 2¾ in. diameter, and 6 in. back focus, for Portraits 5 by 4 in., with a Set of Waterhouse Diaphragms, in case	12	16	0

NEW PATENT PORTRAIT LENSES (B).

2827* 2828	**No. 2 B Patent Lens,** with rack and pinion movement. Diameter of Lenses, 2¾ in., and back focus 6 in. Especially constructed for **Carte de Visite Portraits.** *Distance between subject and lens for a standing figure,* 18 *ft.* With a Set of Waterhouse Diaphragms	13	5	0
2829	**No. 3 B ditto ditto.** Diameter of Lenses 3½ in., and back focus 8 in. Especially constructed for the **Cabinet Portraits.** *Distance between subject and lens for a standing figure,* 18 *ft.* (*for Carte de Visite, distance* 25 *ft.*) With a Set of Waterhouse Diaphragms	20	0	0
2830	**No. 4 B ditto ditto.** Diameter of Lenses 4½ in., and back focus 12 in.; for pictures 8½ by 6½ in. *Distance for a Cabinet Portrait* 25 *ft.* With a Set of Waterhouse Diaphragms, in case	40	0	0

PATENT PORTRAIT LENSES (A).

		Each. £	s.	d.
2831	**No. 1 A*—Patent Lens,** with rack and pinion movement. Diameter of front and back combinations, 2¾ and 2⅝ in. respectively, and 6½ in. back focus; for pictures 5 by 4 in. With a Set of Waterhouse Diaphragms, in case	13	0	0
2832	**No. 2 A* ditto ditto.** Diameter of front and back combinations, 3½ and 3¼ in. respectively; 10 in. back focus; for pictures 6½ by 4¾ in. With a Set of Waterhouse Diaphragms, in case . .	18	0	0
2833	**No. 3 A* ditto ditto.** Diameter of Lenses 4 in., and 12 in. back focus; for pictures 8½ by 6½ in. With a Set of Waterhouse Diaphragms, in case	27	5	0
2834	**No. 4 A ditto ditto.** Diameter of Lenses 4½ in. and 14 in. back focus; for pictures 10 by 8 in. With a Set of Waterhouse Diaphragms, in case	38	10	0

* *These Lenses are well adapted for the Cabinet Portraits, according to length of gallery. Thus No.* 1 **A** *requires a distance of* 14 *feet between subject and lens (not recommended if a longer focus lens can be used), No.* **2 A,** 20 *ft., and No.* **3 A,** 24 *ft.*

PATENT PORTRAIT AND GROUP LENSES (D).

With the exception of No. **3 D**, these Lenses are mounted in Rigid settings, *i.e.*, without rack and pinion movement, and include Central Diaphragms.

	Diam. of Lenses.	Back Focus.	Size of Group.	Size of View.	£	s.	d.
No. 3 D*	Patent 2¼ in.	10½ in.	8½ by 6½ in.	10 by 8 in.	9	10	0
No. 4 D	„ 2⅝	13	10 „ 8	12 „ 10	13	10	0
No. 5 D	„ 3¼	16	12 „ 10	15 „ 12	17	10	0

* *Distance for a Cabinet Portrait with No.* 3 *D,* 18 *ft.*

RAPID RECTILINEAR LENS (PATENT).

Each lens, marked below, with smaller stops, can be used for the next size *larger* view, and is supplied with Waterhouse diaphragms.

Size of View. or Landscape.	Size of Group, or Portrait.	Diameter of Lenses.	Back focus.	Equiv. focus.	Price, Rigid Setting. £	s.	d.	Price, Sliding Tube. £	s.	d.	Price, rack and pinion. £	s.	d.
*5 by 4 in.	4¼ by 3¼ in.	⅞ in.	5½ in.	6 in.	4	10	0	4	15	0	5	5	0
6 × 5 or 8 × 5	5 „ 4 „	1¼ „	7½ „	8¼ „	5	10	0	6	0	0	6	10	0
8½ by 6½ in.	6 „ 5 „	1½ „	10¼ „	11 „	7	0	0	7	10	0	8	0	0
10 „ 8 „	8½ „ 6½ „	1¾ „	12¼ „	13 „	9	0	0	9	10	0	10	5	0
12 „ 10 „	10 „ 8 „	2 „	15 „	16 „	11	0	0	11	10	0	12	5	0
13 „ 11 „	French size	2¼ „	16 „	17½ „	12	0	0	12	15	0	. .		
15 „ 12 „	12 by 10 in.	2½ „	18 „	19½ „	15	0	0	15	15	0	. .		

* *These Lenses are also well adapted for Stereoscopic Views, and can be had in pairs.*

WIDE-ANGLE LANDSCAPE LENS (PATENT).

The Lenses are mounted in Rigid tubes or Settings with Rotating Stops.

No.	Size of Plate.	Diameter. of Lenses.	Equivalent Focus.	Price. £ s. d.	REMARKS.
1A	5 by 4	1⅜	5½	3 5 0	No. 1A and No. 1 are made to screw into the same flange as No. 1 Triple Achromatic Lens.
1	7½ „ 4½	1⅝	7	3 15 0	
2	8½ „ 6½	1⅞	8½	4 10 0	
3	10 „ 8	2⅛	10	5 10 0	
4	12 „ 10	2¼	12	7 0 0	
5	15 „ 12	2⅝	15	8 10 0	Nos. 2 and 3 screw into No. 2 Triple Achromatic flange.
5A	15 „ 12	2⅜	18	9 10 0	
6	18 „ 16	3	18	10 10 0	

N.B.—The Apertures of all the stops supplied with Dallmeyer's Lenses (Portraits, Views and Landscapes) are so arranged that, counting from the LARGEST *to the next size* SMALLER, *the time of exposure is* DOUBLED.

		Each. £ s. d.
2835	**Sky-shades or Shutters** recommended for use with above . .	0 8 6
2836	**Dallmeyer's New Stereoscopic Lens** consists of two Achromatic combinations of 1¼ and 1½ in. diameter respectively, and 3½ in back focus, flat field, and perfect definition.	
2837	**The above,** in Sliding Mount, with Waterhouse Diaphragms, *each*	3 10 0
2838	**ditto, ditto,** with Rack and Pinion movement	4 0 0

2839 **The Patent Stereographic Lens.** Is specially recommended for "Instantaneous Views," Small Portraits, Groups, &c.

Diameter of front and back combinations 1½ in. and 1¼ in. respectively, and 3¾ in. focus from the back glass (equivalent focus 5 inches).

2840	In Sliding Mount, with Waterhouse central diaphragms . . *each*	4 5 0
2841	Ditto ditto, with Rack and Pinion movement . . . . „	4 15 0

N.B.—The front combination can be used alone and *intact* (focal length 8 inches), simply by unscrewing and dispensing with the back combination, when with a small-sized stop, it will be found to cover the 7¼ by 4¼ in. plate. For very short Operating Rooms, this Lens can also be used for **Card Portraits.**

QUICK-ACTING STEREO' LANDSCAPE LENS.

2842	**No. 1.**—1¼ in. diam., 4½ in. back focus, in "rigid" mount, with "rotating" stops	2 0 0
2843	**No. 2.**—1½ in. diam., 6 in. back focus, in "rigid" mount, with "rotating" stops	2 5 0

2844	**Patent Rectilinear Stereo' Lens.** Especially constructed for Architectural and Landscape views in *confined* situations, mounted in rigid setting, with *rotating* diaphragm plate . . . each	4 0 0
2845	**A Rectilinear Lens** of 2 in. back focus (equivalent 2¼ in.), constructed for Tourists' *Pocket* Cameras; size of plate, 3¼ by 2¾ .	4 0 0

Any of the Stereoscopic Lenses can be had in pairs or four of equal foci.

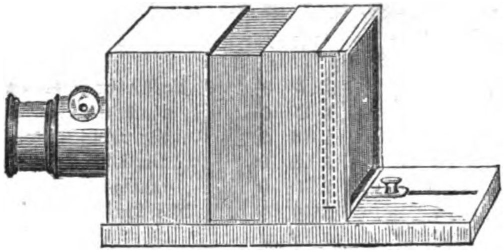


FIG. 2846.

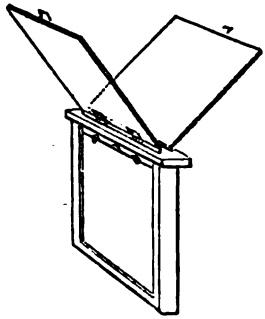


FIG. 2846*.

SLIDING BODY CAMERAS.

OF ORDINARY CONSTRUCTION, FOR TAKING PORTRAITS AND VIEWS EITHER ON GLASS OR PAPER, ETC.

The following Prices are for Cameras only. The price and description of Lenses will be found on pages 473 to 477.

		Each. £ s. d.	Each. £ s. d.
2846	**Square Sliding Body Camera** (fig. 2846), of Polished Honduras Mahogany, with one single back (fig. 2846*), 5 inches square, with two loose frames, for pictures 4¼ by 3¼ in., and 3¼ by 2¾ in., and focusing screen	1 7 6	1 10 6
2847	Ditto ditto of best Spanish Mahogany, with rising front, of superior make and Brass Binding . .		2 15 0
2848	**Square Sliding Body Camera,** for plates 5 by 4 inches and 4¼ by 3¼ inches		1 16 0
2849	Ditto ditto of best Spanish Mahogany, with rising front and Brass Binding		3 10 0
2850	**Square Sliding Body Camera,** for plates 6 by 5 inches, and 5 by 4; inches this size is suited to a single Carte de Visite or Cabinet Size Pictures		2 10 6
2851	Ditto ditto of best Spanish Mahogany, and rising front and Brass Binding		4 15 0
2852	**Square Sliding Body Camera,** for plates 8½ by 6½ inches, 6 by 5 inches, and 5 by 4 inches		4 4 0
2853	Ditto ditto of best Spanish Mahogany, with rising front and Brass Binding		7 10 0
2854	**Square Sliding Body Camera,** for plates 12 by 10 inches, 10 by 8 inches, and 8½ by 6½ inches		7 7 0
2855	Ditto ditto of best Spanish Mahogany, with rising front and Brass Binding		13 13 0
2856	**Square Sliding Body Camera,** as fig. 2846, of best Polished Honduras Mahogany, with one single back 18 inches square, three loose frames, for plates 16 by 14 inches, 14 by 12 inches, and 12 by 10 inches, and focusing glass		12 12 0
2857	Ditto ditto of best Spanish Mahogany, with rising front and Brass Binding		35 0 0

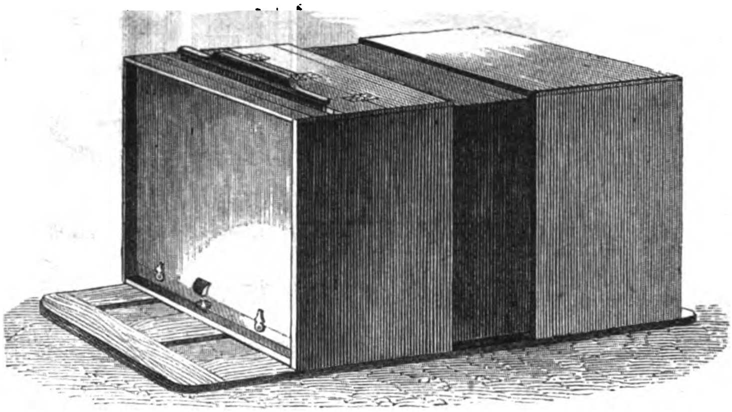


FIG. 2862.

SLIDING BODY CAMERAS.

ADAPTED FOR PORTRAITS AND VIEWS BY ANY PROCESS ON GLASS OR PAPER.

		Each. £ s. d.	Each £ s. d.
2858	**Sliding Body Camera,** of French Polished best Spanish Mahogany, with one single dark slide for Glass plates, or paper for Portraits 4¼ by 3¼ inches, and Views 6½ by 4¾ inches, and focusing glass, with rising front, and superior make, Brass Bound . .		6 6 0
2859	Ditto ditto of best Spanish Mahogany, with rising front, Brass Bound		8 8 0
2860	**Sliding Body Camera,** for Portraits 6 by 5 inches, or Views, 9 by 7 inches, of best Spanish Mahogany, with rising front, Brass Bound. This Camera is suited for Cabinet sized Portraits		10 10 0
2861	**Sliding Body Camera** (fig. 2846), for Portraits 8½ by 6½ inches, and Views 11 by 9 inches, of best Spanish Mahogany, French polished, and with rising front, Brass Bound		14 14 0

2862 **Sliding Body Expanding Cameras of large size, for Operating Room** (fig. 2862), best Spanish Mahogany French polished Square Sliding body Camera, with inner body panelled, and Screw Adjustment working from side of Camera; Swing Back, Rising Front; one single back, three inner loose frames, and focusing screen :—

		Plain.	Brass Binding, Extra.
No. 1 for plates	10 by 8 in.	£13 10 0	£2 2 0
No. 2 „	12 by 10 in.	17 10 0	3 3 0
No. 3 „	15 by 12 in.	21 0 0	3 10 0

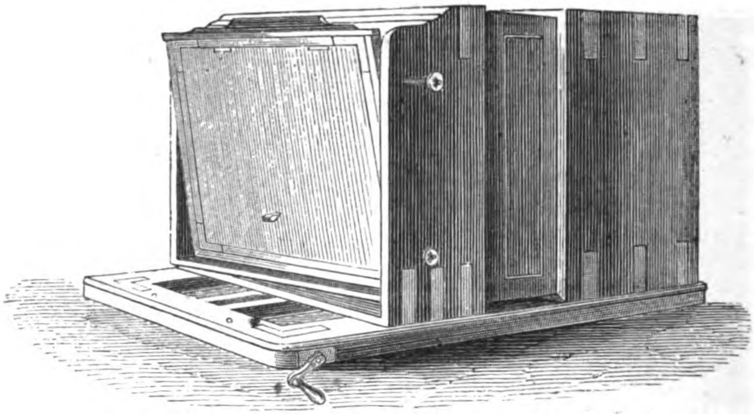


FIG. 2863.

2863 **Square Tiunk Rigid Camera for Operating Room** (fig. 2863), Spanish Mahogany French polished, with long-screw adjustment, enabling the operator to use lenses of different focal lengths; and for copying, with swinging back. for bringing objects at various distances into correct focus; one single back, inner loose frames, and focusing screen:—

	Plain.	Framed and Panelled. Extra. Each.	Brass Bound. Extra. Each.
No. 1 for plates 12 by 10 in. . . .	£14 10 0	£4 4 0	£2 2 0
No. 2 „ 18 by 16 in. . . .	21 10 0	8 8 0	3 10 0

2864 **Single or Double Backs for Cameras** (figs. 2864, 2864*, and 2864†):—

	Single Backs and 2 inner Frames.	Double Backs.	Brass Binding, Extra.
For Plates 6¾ by 3¼ . .	£0 12 0	£0 17 6	4/ and 5/
„ 7 by 6 . .	0 18 0	1 4 6	4/6 „ 5/6
„ 7¼ by 4½ . .	1 1 0	1 11 6	5/6
„ 8 by 5 . .	1 1 0	1 11 6	5/6
„ 8½ by 6½ . .	1 2 0	1 11 6	5/ „ 5/6
„ 9 by 7 . .	1 4 6	1 12 6	5/ „ 6/
„ 10 by 8 . .	1 8 0	1 16 6	5/6 „ 6/6
„ 11 by 9 . .	1 10 6	2 2 0	6/ „ 7/
„ 12 by 10 . .	1 15 0	2 4 0	6/ „ 7/

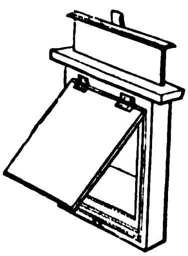


FIG. 2864.

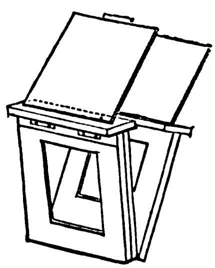


FIG. 2864*.

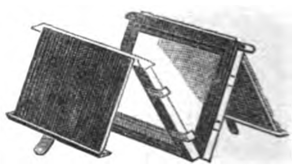


FIG. 2864†.

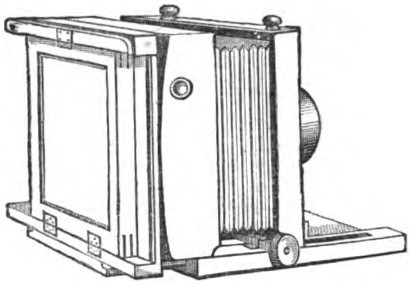


FIG. 2865.

2865 **Universal Camera for the Studio.** Is adapted for single or double *Carte de Visite*, for half or whole plate Portraits, for the **New Cabinet Pictures**, and can also be used for Copying. It possesses so many advantages that no other Camera is necessary for ordinary work in the Studio.

	Price for plates 6 in. Square, including Swinging Back . .	£6 6 0
2866	Ditto Universal Camera for the Studio for plates 8½ square (fig. 2865)	7 7 0

2867 **Sliding Body Folding Camera.** Best Spanish Mahogany, French polished, sliding body Folding Camera, with one Single Back, two loose frames, Focusing Glass in frame, and with vertical and horizontal Sliding Front for adjustment of foreground and sky (fig. 2867).

		Plain. (fig. 2867)	Brass Binding. (fig. 2867*) Extra.
No. 1 for plates	9 by 7 in.	£6 10 0	£1 6 0
No. 2 „	10 by 8 in.	7 10 0	1 15 0
No. 3 „	12 by 10 in.	10 10 0	1 15 0
No. 4 „	15 by 12 in.	12 12 0	2 2 0

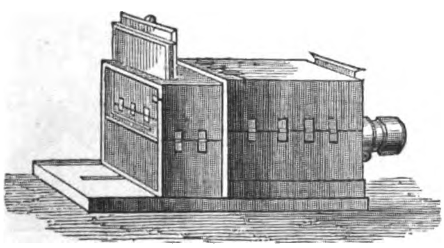


FIG. 2867.

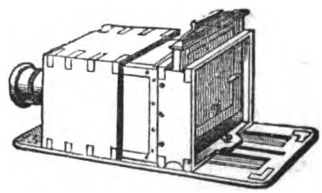


FIG. 2867*.

The above can be had framed and panelled, or with fine screw focusing adjustment, at an additional cost.

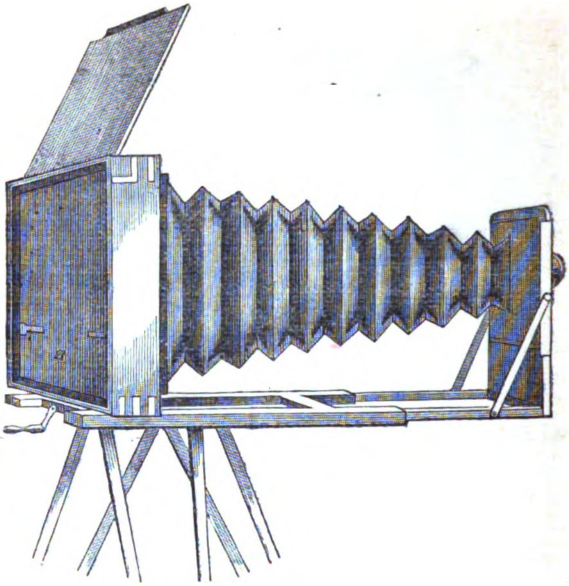


FIG. 2868.

2868 **Kinnear's Camera,** with Conical Bellows body; fig. 2868 represents the Camera open for use, and fig. 2868° when closed up, forming a very portable package (a 10 by 8 Camera, weighing about 7 lbs.); single back, two loose frames, focusing screen, and screw adjustment:—

					Brass Binding. Extra.		
		Plain.					
No. 1 for plates 10 by 8 in.	£6	10	0	£1	5	0
No. 2 " 11 by 9 in.	7	15	0	1	10	0
No. 3 " 12 by 10 in.	8	15	0	2	0	0
No. 4 " 15 by 12 in.	10	10	0	2	0	0
No. 5 " 18 by 16 in.	16	10	0	2	10	0

The above Cameras can be supplied with Swing Backs at an extra rate.

For India, N. and Z. recommend the Bellows to be of Russia Leather to resist ravages of insects, though the cost is considerably increased thereby.

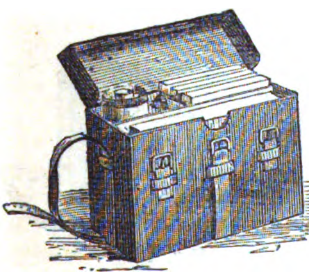
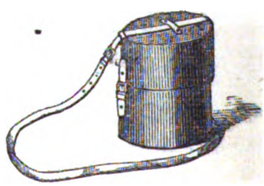


FIG. 2868*.



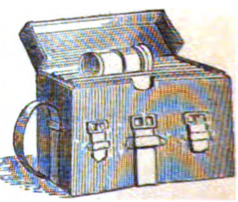


FIG. 2868*.

2868* **Solid Leather Cases and Sling Straps,** for Plain, Folding, or Sliding **Body** Cameras, or for Lenses, (fig. 2868°) &c., &c., *made to order.*

IMPROVED PORTABLE BELLOWS CAMERAS.

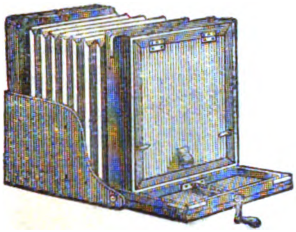


FIG. 2869.

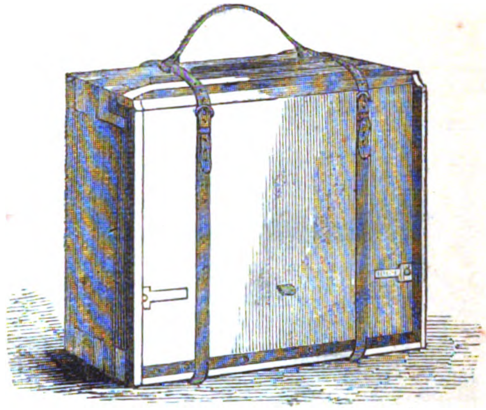


FIG. 2868*.

2869 **Improved Portable Bellows Camera.** These Cameras are capable of adjustment for both Portrait and Landscape Lenses. The focusing is obtained by an endless Screw or rack and pinion movement. The improved Portable Cameras are made either with a Conical Bellows body, or with a Parallel Bellows and folding base.

Prices, with 1 single back and two inner frames, as fig. 2869:—

For Plates.	Horizontal and Vertical Conical Bellows.	Square.	Horizontal and Vertical Parallel Bellows and Folding Bottom.	Square.	Swinging Back.
in. in.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
4¼ by 3¼	. .	. .	2 19 6	3 10 6	. .
5 by 4	. .	. .	3 8 6	3 19 6	. .
6½ by 4¾	. .	. .	5 15 0	6 15 0	0 18 6
8½ by 6½	5 15 0	6 5 0	6 0 0	6 15 6	1 4 6
10 by 8	6 10 0	7 0 0	7 0 0	7 17 6	1 8 6
12 by 10	8 10 0	9 5 0	8 10 0	9 10 0	1 10 6
15 by 12	10 10 0	11 0 0	10 10 0	12 2 6	1 12 6
18 by 16	16 15 0	17 15 0	17 10 0	20 10 0	1 16 6

MESSRS. NEGRETTI AND ZAMBRA, being exclusively engaged as Photographers to the Crystal Palace Company, they are enabled from great practical experience to supply such Apparatus as will really be of service to a Photographer; and as the greater part of the articles enumerated are made under their own immediate superintendence, and finished with all the most recent and really serviceable improvements, they will be found to work so as to present the least possible chance of failure.

Cameras and other Photographic Cabinet work intended for use in India, or any Hot Climates, should be made of the very best seasoned Spanish Mahogany, and clamped with Brass, to insure durability.

STEREOSCOPIC CAMERAS.

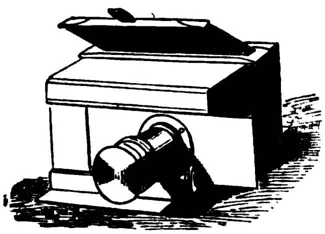


FIG. 2870.

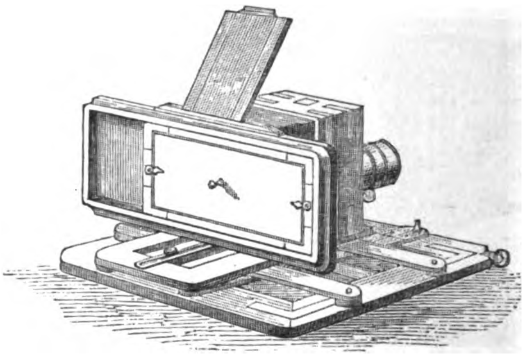


FIG. 2871.

ACHROMATIC SINGLE LENS STEREOSCOPIC CAMERAS.

		£	s.	d
2870	**Stereoscopic Camera,** of most simple construction, fitted with Compound Lens for Views, mounted on sliding front to take the stereoscopic pictures at two exposures; one single back for plates and ground glass (fig. 2870)	3	10	0
	The pictures taken with this Camera require to be reversed when mounted, to obtain the stereoscopic effect.			
2871	**Stereoscopic Camera,** of best construction, mounted on boards, with parallel adjustment, Latimer Clarke's principle, adjusting screw, long shifting back for stereoscopic plates, and ground focusing glass (fig. 2871)	3	10	0
2872	**Single Back,** adapted to the above, with loose frame for Portraits .	0	11	6
2873	**Negretti and Zambra's Compound Achromatic Lens,** with Waterhouse Stops for use with the above, for Portraits or Views	2	15	0
2874	**Very Superior Spanish Mahogany Sliding Body Camera** (fig. 2874), with Rising Front and Rack Separation for Lenses, shifting bar for connecting caps of lenses, one single back, to take plates 7¾ by 4¼ inches, loose frame for Stereoscopic size, 6¾ by 3¼, ground focus glass, and two of Negretti and Zambra's Compound Achromatic Lenses, fitted with Waterhouse stops, suited for Stereoscopic Portraits or Views	7	7	0

N.B.—This Camera with its lenses is also adapted for two Carte de Visite pictures on the plate, 7¾ by 4¼ inches.

It is necessary to state that the pictures taken by this Camera require to be reversed when mounted, to obtain the true stereoscopic effect.

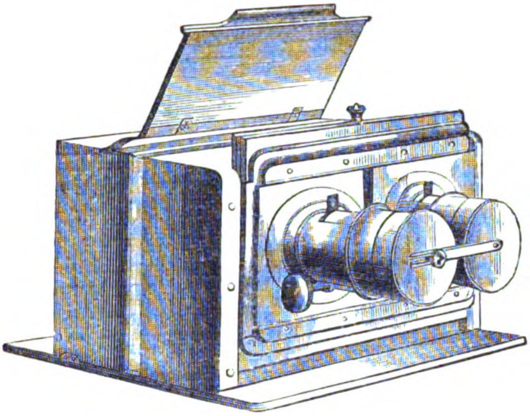


FIG. 2874.

IMPROVED TOURISTS' STEREOSCOPIC CAMERAS.

		Each. £ s. d.
2875	**Negretti and Zambra's Improved Tourists' Binocular Stereoscopic Bellows Body Camera** with Screw adjustment to Camera for focusing; three double backs, each for holding two prepared plates, size 6¾ by 3¼ inches, and one single back, for wet or dry process; focusing glass; very portable, packing into a Mahogany case; outside dimensions 8¾ by 5½ inches, price with two Achromatic View Lenses	9 10 0
2876	Or with two of Negretti and Zambra's Compound Achromatic Lenses with Waterhouse stops, for Portraits and Views . .	12 12 0

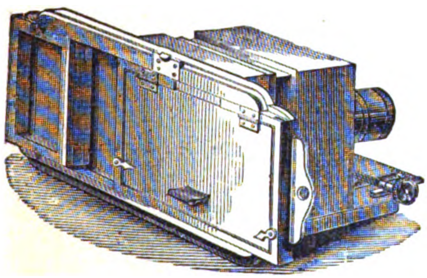


FIG. 2877.

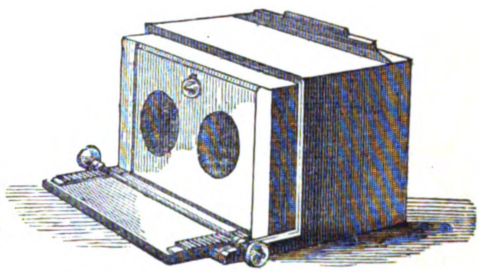


FIG. 2878.

CARTE DE VISITE CAMERAS.

2877	**Negretti and Zambra's Improved Single Lens Carte de Visite Camera** (fig. 2877), arranged for taking two pictures on one plate 6½ in. by 4¾ in. This Camera is of the Sliding body form, with **improved rack motion for focusing lenses from the front,** and made of the best Spanish mahogany, with long frame for containing the back and focusing screen, with Brass Binding .	5 5 0
2878	**Negretti and Zambra's Improved Double Lens Camera,** as per fig. 2878, for Operating Room, of best Spanish mahogany, with Rack adjustment, focusing from front, Rising Front, one single back and focusing glass, with Brass Binding	5 12 0

For prices of suitable Lenses for above Cameras, see pages 473 to page 477 according to length of Operating Room.

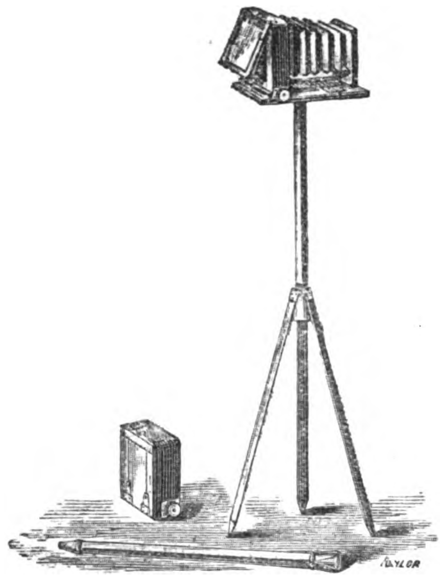


Fig. 2879.

2879 **The Pocket or Satchel Camera, with Walking-Stick Tripod Stand,** for working the Dry Collodion process (fig. 2879)

2880 **A Portable Pocket or Satchel Camera,** of the best construction, for plates 4¼ by 3¼ inches, with three double backs, portable Tripod Stand and View lens £8 8 0

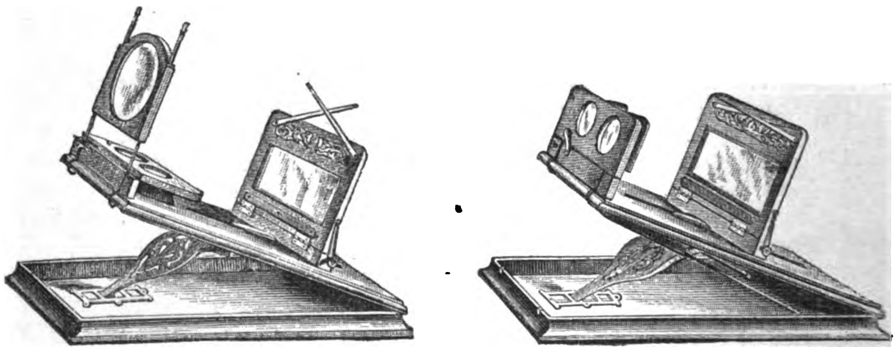
2881 The above Camera packed in a box with the necessary chemicals for developing dry plates. Developing cups and dish, plate box, and printing frame £10 10 0

2882 **A Portable Satchel Camera,** as above, with three double backs, for plates 5 by 4 inches, portable tripod stand and View lens £10 10 0

No.	Description	Each. £	s.	d.
2883	The above, with Chemicals, &c., for developing Dry Plates, Packed in Box	12	12	0
2884	**A Portable Satchel Camera,** for Stereoscopic Pictures, with three double backs, and a Pair of Lenses, and a portable Tripod stand.	12	12	0
2885	The above, with Chemicals, &c., for developing dry plates, packed in box	15	15	0
2885*	**Prepared Dry Plates** for use with the Satchel Camera 4¼ by 3¼ per dozen	0	4	0
	Ditto ditto 5 by 4 . . . . . . "	0	5	6

2886 **Leather Sling Cases,** for either of the above Cameras, can be had at an extra charge of 18s., £1 1s., and £1 5s.

No.	Description	£	s.	d.
2887	**Micro-Photographic Camera,** complete with Achromatic Lenses, for reducing pictures, &c.	10	10	0
2897	**Enlarging, Copying, or Solar Cameras** Made to Order.			



The Improved Graphoscope; for particulars and prices see page 261.

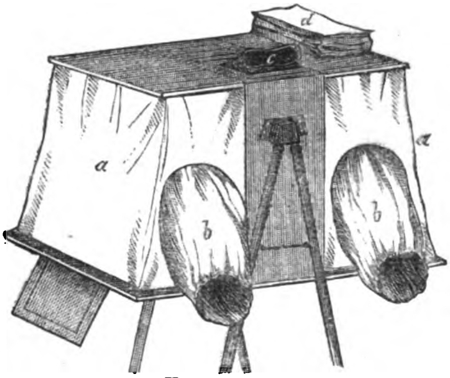


FIG. 2888, NO. 1.

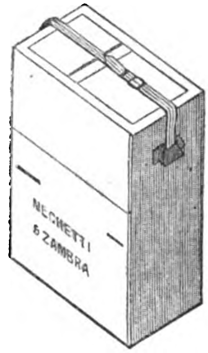


FIG. 2888, NO 2.

2888 **The Improved Developing Box** is constructed for working the Wet or Dry Collodion processes. To Amateurs, especially, it offers many advantages over the ordinary Dark Tent, which is weighty and cumbersome. Fig. 1 shows the box open, ready for use; Fig. 2, closed. The sides *a a*, Fig. 1, open up and down, and are kept in their position by two braces of wood inside. The hands enter at the sleeves as shown at *b b*, Fig. 1, and the mask, *c*, which is of black cloth on a wire frame, is set in the door, on top, under which is a plate of white glass to keep the vapour of the collodion from the eyes, and a sliding door under the glass to shut out the light when the face is withdrawn. The bath is let through the bottom at the left hand corner. The yellow glass window is directly opposite the operator. It is provided with a zinc or other kind of tray, with waste water pipe; also a cistern, *d*, of india-rubber, for water. Sufficient room will be found inside for the necessary bottles, and a plate-draining box. The size of this box when closed and capable of manipulating a plate 8½ by 6½ with freedom is 15 by 13 by 7.

Prices according to size and arrangement of fittings, £4 10 0 to £6 6 0

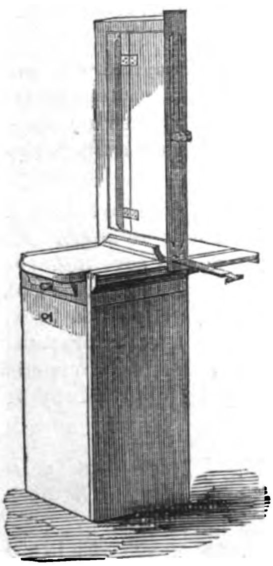


FIG. 2889.

2889 CHANGING BOXES, OR DARK BOXES.

FOR TRANSFERRING DRY PLATES TO CAMERA BACKS IN OPEN AIR, &C. (FIG. 2889).

These boxes can be adapted to any sized Camera, but require the Camera back to be specially made for the purpose.

			£	s.	d.
For Stereoscopic size, to hold 1 doz. plates			£3	3	0
For size 7 by 6 in.	„	„	3	12	6
„ 9 by 7 in.	„	„	4	10	0
„ 10 by 8 in.	„	„	4	16	6
„ 11 by 9 in.	„	„	5	12	6
„ 12 by 10 in.	„	„	6	6	0

The same construction of changing box can be applied to double backs, where two plates can be changed at one operation, at an additional expense.

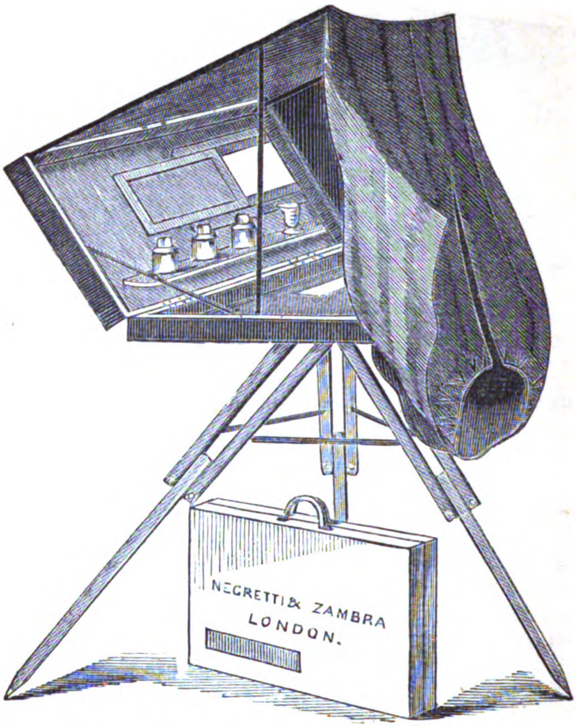


FIG. 2890.

2890 **Improved Portable Dark Tent,** for working the Collodion Process in the open country (fig. 2890).

A good substitute for a dark room has long been a desideratum, and we have much pleasure in submitting the present invention to the notice of photographers generally, as combining all that can be required for the purposes of open air work, enabling them to work with as perfect ease and comfort as in their own laboratory at home.

The tent consists of a strong box forming a convenient table, mounted upon a firm tripod stand. The lid of the box is hinged, and thrown back at an angle. At each corner of the lid metal rods are fitted into sockets to extend the covering over the head, having also supports at each side, as shown in the engraving (fig. 2890). In the lid is a yellow glass sliding shutter for admitting light, or if pushed back, fresh air to the interior of the tent, when desired. This tent has been in practical use for some time, and is found to answer perfectly and fulfil all the requirements of a photographic tent. The outside measurement, when packed up, is 31 by 21 by 4; weight, with stand and covering, 25 lbs.

Size .	31 by 21 by 4	£6 6 0
„ .	26 by 19 by 4	5 5 0
Ditto with water tank fitted inside, &c., and other improvements		£8 8 0 to 12 12 0

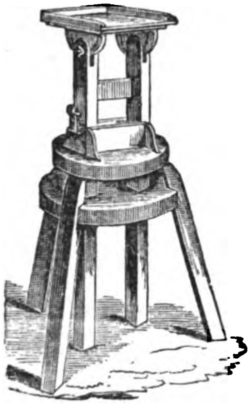


FIG. 2899.

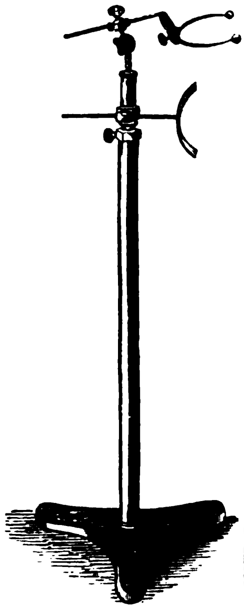


FIG. 2904.

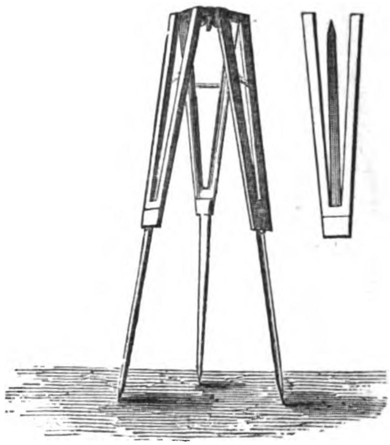


FIG. 2895.

CAMERA STANDS.

To insure success in taking either Portraits or Views, it is absolutely essential that the Camera should be perfectly steady. Lightness, with freedom from vibration, are combined in the Stands offered in the following list:—

		Each.			Each.		
		£	s.	d.	£	s.	d.
2891	**Tripod Stand,** with round metal top, and bolt screw. Double legs of ash for small Camera (fig. 2891) .	0	10	6	0	15	0
2892	**Tripod Stand,** with 4-inch triangular metal top (fig. 2892), with double legs and brass stretchers, bolt, screw, and nut, with straps				1	1	0
2893	Ditto ditto very strong, with 6-inch triangular metal top, with bolt and screw, double legs of ash, polished, and hinged with brass stretchers . .				1	6	0
2894	Ditto Ditto larger, with 8-inch triangular head for large sized Camera, very firm				1	12	6
2895	**Folding Tripod Stand,** light and portable, three legs, as per fig. 2895, of new pattern, suitable for Stereoscopic Cameras . . . . 4 inch head	1	5	0	1	10	0
2896	Ditto ditto . . . . 5 inch head				1	12	6
2897	Ditto ditto . . . . 6 inch head				1	16	0
2898	**Improved Adjusting Tripod Stand,** the Legs having a sliding-up and clamp adjustment for height, firm and portable	2	2	0	2	10	0
2899	**Table Camera Stand,** with adjustments for raising or depressing the Camera, for Operating Room . .				1	10	6
2900	**Table Camera Stands,** in Polished oak, very strong, metal rack adjustment, with handle for raising or depressing Camera, also horizontal and vertical motion to top of stand (fig. 2899)				6	10	0

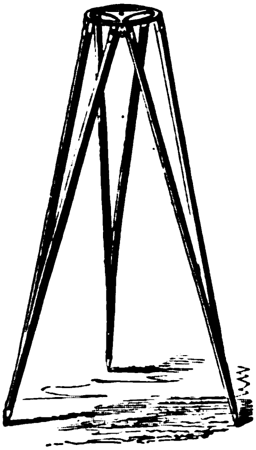
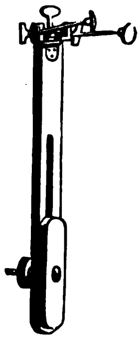
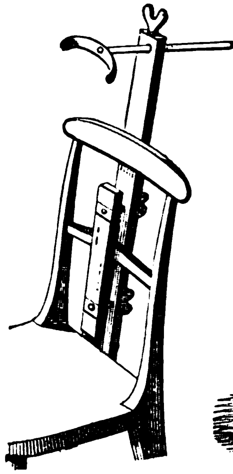
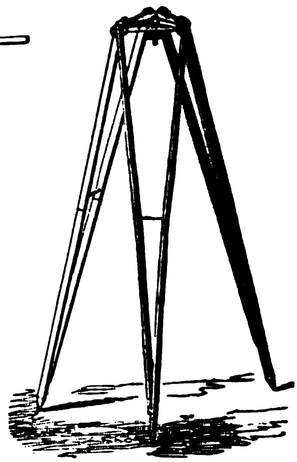





FIG. 2891. FIG. 2901. FIG. 2902. FIG. 2892.

HEAD RESTS.

No.	Description		Each. £ s. d.	Each. £ s. d.
2901	**Head Rest,** of simple form, with screw to attach to back of chair (fig. 2901)			0 2 6
2902	Ditto ditto with adjustments for raising and depressing with screw to attach to back of chair (fig. 2902) .			0 5 6
2903	**Negretti and Zambra's Universal Head Rest,** with means of adjustment for every position of the sitter, for attaching to chair			1 7 6
2904	**Universal Head or Body Rest,** with heavy iron foot, and brass sliding tube, which enables this Rest to be used either for standing or sitting posture (fig. 2904) Of various sizes for children or adults.	£2 10 0	3 3 0	4 4 0

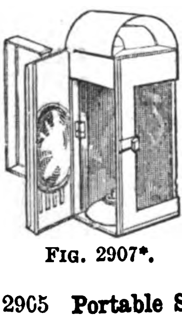
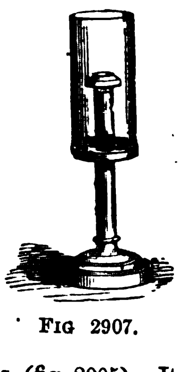
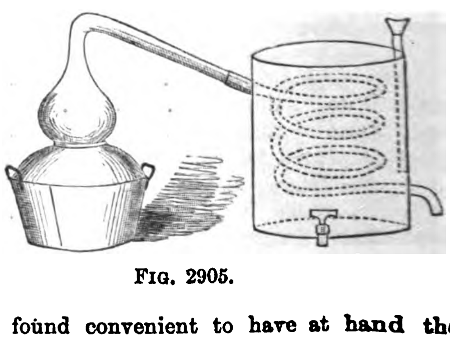




FIG. 2907*. FIG 2907. FIG. 2905.

2905 **Portable Stills** (fig. 2905). It is found convenient to have at hand the means of obtaining Pure Water. See page 366 for Prices and sizes, &c.

LAMPS FOR DARK ROOM.

		Each. £ s. d.	Each. £ s. d.
2906	**Bunsen's Gas Burners,** for boiling or distilling; Gas Jets, with flexible tube, metal chimney, and gauze wire, for burning without smoke, see *ante*, page 362.		
2907	**Lanterns** furnished with Yellow Glass Shades, for use in dark room (fig. 2907)		0 4 6
2907°	**Improved form of Photographic Non-Actinic Lamp,** where the yellow or ruby glass can be raised or depressed (fig. 2907°)		0 10 6
2907†	**Patent Lamp for the Magnesium Light**		2 10 0

FIG. 2982.

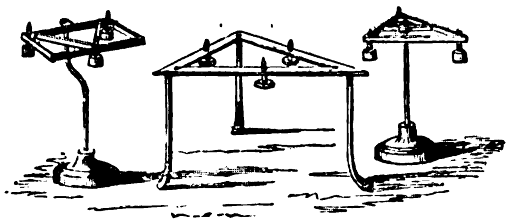


FIG. 2908.

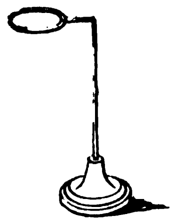


FIG. 2908*.

LEVELLING STANDS, TRIANGULAR PATTERN.

		Each. £ s. d.	Each. £ s. d.
2908	With adjusting screws, for levelling plates with Albumen, and Developing and Fixing Collodion Pictures (figs. 2908) :—		
	For plates up to 5 by 5 inches		0 3 0
	Ditto ditto 7 by 6 „		0 4 6
	Ditto ditto 9 by 7 „		0 5 6
	Ditto ditto 12 by 10 „		0 6 6
2908°	**Filter Supports** (fig. 2908*), plain form		0 2 6

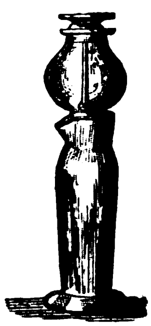


FIG. 2910.

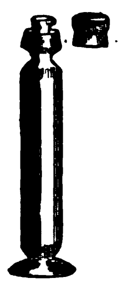


FIG. 2909.

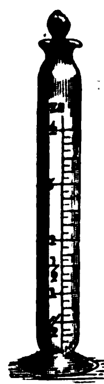


FIG. 2908*.

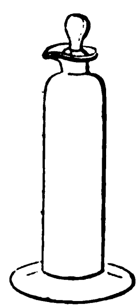


FIG. 2908.

COLLODION BOTTLES POURERS, AND FILTERS.

The Collodion Bottles (figs. 2908 to 2909) can be used either for mixing the plain Collodion with the Iodiser, or for receiving the turbid portion of Collodion when it has been poured over the plate several times; from the shape of the bottle, it allows all particles to subside at the bottom, and enables the operator, after a short time, to pour away the clear Collodion within a very short distance of the deposit, without disturbing it.

2908† **Collodion Bottle or Pourer:—**

(Fig. 2908*) Plain . . .	2 oz.	4 oz.	6 oz.
Price	2s.	3s.	3s. 6d.
(Fig. 2908†) Graduated . .	2 oz.	4 oz.	6 oz.
Price	3s.	4s.	4s. 6d.

2909 **Cometless Collodion Bottle** (fig. 2909). The tube in the neck of this bottle can be removed and cleaned as frequently as used, and so particles of dry Collodion prevented from being carried on to the plate . . £0 4 0

2910 **Collodion Filters** (fig. 2910) 5s. 6d. £0 7 6 0 10 6

2911 **Drop Bottles, Improved,** for adding small quantities of Nitrate of Silver Solution to developing or other solutions (see Nos. 1740, 2788, and page 464).

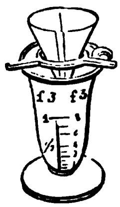


FIG. 2919.

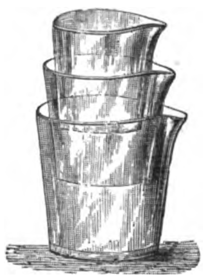


FIG. 2912.

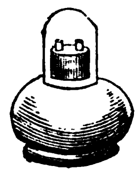


FIG. 2920.

No.	Article	Each. £ s. d.	Each. £ s. d.
2912	**Developing Glasses,** nest of three, for pouring developing solution on to plates (fig. 2912)		0 4 0
2912°	Ditto Graduated :		0 5 6
2913	**Hydrometers,** for testing the Specific Gravity of Acids, Alcohol, Æther, &c. . . . . (see pages 153 to 170).		
2914	**Argentometer,** for testing strength of silver bath, in case	0 2 6	0 3 6
2915	Ditto with glass solution Tube in case . . .		0 4 6
2916	**Dropping Tubes or Pipettes**	0 0 6	0 0 8
2917	**Dropping Tubes,** Graduated . . . . . 1s. 6d.	0 2 6	0 5 6
2918	**Glass Graduated Measures,** accurately divided into Minims, Drachms, and Ounces; of either Cylindrical or Conical form, see page 343.		

Scales and Weights see *ante*, pp. 355, 359, 366.

2919 **Filter Rings, or Supports,** as on top of fig. 2919, very useful for filtering small quantities without a funnel 0 0 6 0 1 0

2920 **Glass Syringes,** for taking up small quantities of Liquids, Glass Spirit Lamps, Glass Funnels, Glass Stirring Rods, see pages 340, 349, and 350.

2921 **Thermometers, Chemical** and various (see page 137).

No.	Article	Each. £ s. d.	Each. £ s. d.
2922	**Wedgwood Ware Funnels**, ribbed inside, see page 340.		
2923	**Ebonite Funnels**:—		

Capacity	2 oz.	4 oz.	8 oz.	16 oz.
Price	1s. 4d.	1s. 9d.	2s. 6d.	4s.

2924 **Filter Paper**, cut round, in packets of 100 each:—

Diameter	5½-in.	7¼-in.	9¼-in.	13-in.
Price	1s.	1s. 3d.	1s. 6d.	2s.

No.	Article	Each. £ s. d.	Each. £ s. d.
2925	**Pneumatic Plate Holder**, small, with lever		0 3 0
2926	Ditto ditto large, with lever (fig. 2926)		0 4 0
2927	**Cup Pattern** Plate Holder		0 4 6
2928	Ditto large size		0 5 0
2929	**Plate Cleaner**, with screw adjustment, for cleaning plates of various sizes (fig. 2929)	0 5 6	0 6 6

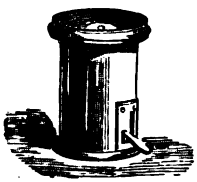


FIG. 2926.

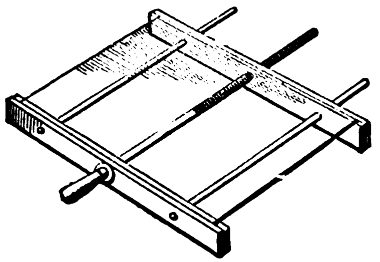


FIG. 2929.

COLLODION DIPPING BATHS.

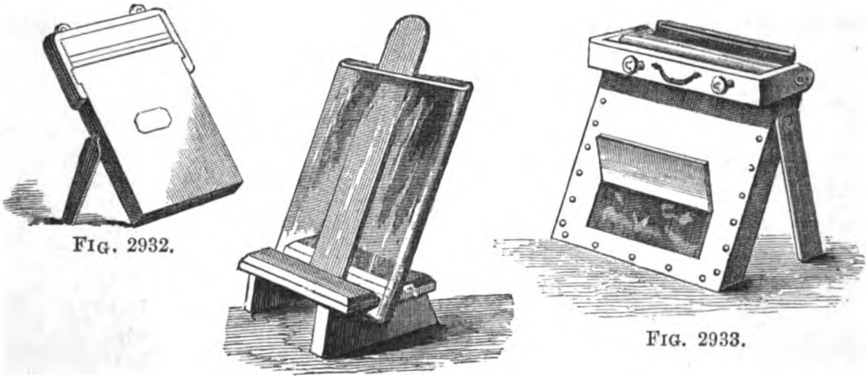


FIG. 2932.

FIG. 2933.

FIG. 2931.

2930 **Patent Ebonite Baths**:—Various sizes supplied to *orders*.

2931 **Glass Nitrate of Silver Dipping Baths,** of Solid Glass, with stand, and glass Dipper (fig. 2931) :—

For Plates	4¼ by 3¼-in.	£0	4	6	For Plates	7¼ by 4½-in.	£0	8	6
,,	5 by 4 in.	0	6	0	,,	9 by 7 in.	0	10	6
,,	6½ by 4¾ in.	0	7	6	,,	10 by 8 in.	0	15	0
,,	6 by 5 in.	0	7	6	,,	12 by 10 in.	0	18	6
Stereoscopic	6¾ by 3¼ in.						0	6	6

2932 **Water-tight Glass Baths,** with Dipper, mounted in Polished Mahogany cases (fig. 2932):—

For Plates	5 by 4 in.	£1	2	6	For Plates	10 by 8 in.	£2	2	0
,,	6½ by 4¾ in.	1	8	6	,,	12 by 10 in.	2	8	6
,,	8½ by 6½ in.	1	12	0	,,	15 by 12 in.	3	13	0
,,	9 by 7 in.	1	14	0	Stereoscopic	6¾ by 3¼-in.	1	5	0

2933 **Negretti and Zambra's Improved Water-tight Glass Baths** (fig. 2933), with accurately fitted glass cover. The top is hinged, and when the bath is in use it can be turned over, as in figure, and at once be put into its place when the bath is out of use; a shutter is placed at bottom, lined with yellow glass, so that the bottom of bath can be examined as to its freedom from sediment; this contrivance will be found of great use in Tropical Climates (screwed and brass bound):

For Plates	5 by 4 in.	£1	12	6	For Plates	7¼ by 4½ in.	£2	7	6
,,	6½ by 4¾ in.	2	3	6	,,	11 by 9 in.	3	15	0
,,	9 by 7 in.	2	10	6	,,	12 by 10 in.	4	8	0
,,	10 by 8 in.	3	3	0	,,	15 by 12 in.	4	18	6
Stereoscopic Size	6¾ by 3¼ in.						1	18	6

2934 **Porcelain Dipping Baths**:—

			Bath.	Stand.	Dipper.	Complete.
No. 1	for Plates	4¼ by 3¼ in.	2/	/8	/8	3/4
2	,,	5 by 4 in.	3/	/10	/11	4/9
3	,,	6½ by 4¾ in.	3/6	1/	1/2	5/8
4	,,	8½ by 6½ in.	4/	1/6	1/6	7/
5	,,	9 by 7 in.	5/6	1/8	1/8	8/10
6	,,	10 by 8 in.	8/	2/	1/10	11/10
7	,,	12 by 10 in.	11/6	2/6	2/	16/
8	,,	15 by 12 in.	23/	3/	3/	29/
9	Stereoscopic size	6¾ by 3¼ in.	4/	1/	1/	6/

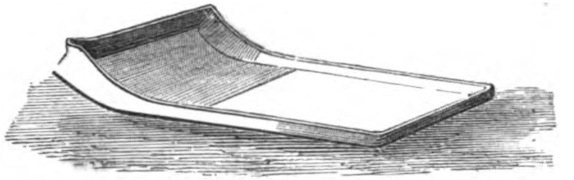


FIG. 2939.

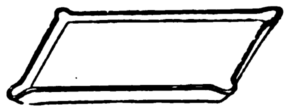


FIG. 2935.

2935 **Porcelain Dishes,** with Spout, for Sensitizing or Albumenizing Paper, and for Washing Paper Pictures (figs. 2935 and 2935*):—

		Porcelain Pans, Shallow.	Porcelain Pans, Deep.
No. 1	for Paper 5 by 4 in.	£0 0 9	£0 0 11
2	Stereoscopic 6¾ by 3½ in.	0 1 0	0 1 3
3	for Paper 8 by 6 in.	0 1 3	0 1 6
4	„ 9 by 7 in.	0 1 6	0 1 9
5	„ 10 by 8 in.	0 1 9	0 2 0
6	„ 11 by 9 in.	0 2 6	0 2 9
7	„ 12 by 10 in.	0 3 0	0 3 6
8	„ 13 by 11 in.	0 4 0	0 5 0
9	„ 16 by 12 in.	0 6 6	0 7 6
10	„ 16 by 13 in.	0 7 0	0 8 6
11	„ 19 by 12 in.	0 9 0	0 10 6
12	„ 20 by 16 in.	0 15 0	0 17 6
13	„ 24 by 19 in.	1 1 0	1 5 0

2936 **Dippers, of Fluted Glass, for Collodion Baths,** in one piece, allowing the fluid to drain down from the back of the plate:—

Length 6 inches each	£0 0 8	Length 11 inches each	£0 1 2
„ 8 „	0 0 10	„ 13 „	0 1 6
„ 9 „	0 1 0	„ 16 „	0 1 10

2937 **Porcelain Dippers,** see No. 2934.

2938 **Silver Wire Dippers,** from 10s. 6d. upwards, according to size and weight.

2939 **Well Porcelain Sensitizing, Developing, or Fixing Dishes.** These dishes are very convenient for sensitizing wet or dry Collodion Plates, or for their subsequent manipulation a very small quantity of solution being required (fig. 2939):—

For Plates 6¾ by 3¼ in.	£0 2 6	For Plates 10 by 8 in.	£0 7 6
„ 6½ by 5 in.	0 3 6	„ 11 by 9 in.	0 9 0
„ 8½ by 6½ in.	0 5 6	„ 12 by 10 in.	0 10 6
„ 9 by 7 in.	0 6 6		

2940 **Ebonite Trays,** of various sizes, supplied to order.

2941 **Moulded Glass Dishes** (fig. 2935). These dishes are entirely unacted upon by the chemicals employed, and can be used without risk:—

	Each.		Each.
Size, 7¼ by 3¾ by 1 in.	£0 2 6	Size, 10 by 8 by 1 in.	£0 6 6
„ 6 by 4½ by 1 in.	0 3 0	„ 11 by 9 by 1 in.	0 7 6
„ 8 by 6 by 1 in.	0 4 0	„ 12½ by 10½ by 1 in.	0 10 6
„ 9 by 7 by 1 in.	0 5 6		

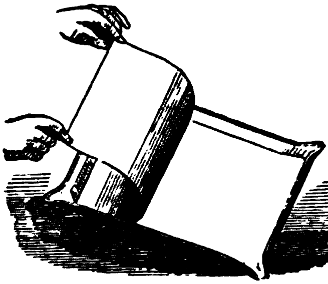


FIG. 2935*.

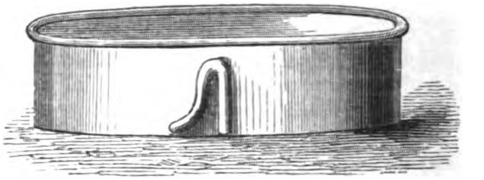


FIG. 2942.

2942 **Elliott's Syphon Washing Trough,** in Porcelain (fig. 2942). Very useful for operators or amateurs, as by the use of it a number of prints may be subjected to the action of a continuous stream of water for any time. When the height of the water reaches the bend of the syphon, the water from the lower part of the pan passes away through the syphon which is then self-acting as long as the water is allowed to pass into the pan.

Price 14s. 6d. 17s. 6d. £1 1s.

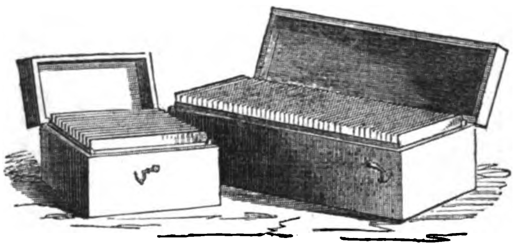


FIG. 2943.

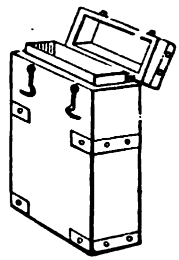


FIG. 2944.

2943 **Plate Boxes** (fig. 2943), for holding **Glass Plates,** in plain, well seasoned **Pine Wood:—**

	For 12 Plates. £ s. d.	24 Plates. £ s. d.	50 Plates. £ s. d.
No. 1 for plates 3¼ by 2¾ in.	0 2 0	0 2 9	0 4 0
2 „ 4¼ by 3¼ in.	0 2 6	0 3 3	0 4 6
3 „ 5 by 4 in.	0 3 2	0 3 6	0 5 6
4 „ 6½ by 4¾ in.	0 3 6	0 4 6	0 6 6
5 „ 6¾ by 3¼ in.	0 3 6	0 4 6	0 6 6
6 „ 6 by 5 in.	0 3 8	0 4 6	0 6 6
7 „ 7 by 6 in.	0 4 0	0 4 6	0 7 6
8 „ 8½ by 6½ in.	0 4 6	0 5 0	0 8 6
9 „ 7¾ by 4½ in.	0 3 9	0 4 6	0 7 6
10 „ 7¼ by 4½ in.	0 3 9	0 4 6	0 7 6
11 „ 9 by 7 in.	0 4 6	0 5 6	0 8 6
12 „ 10 by 8 in.	0 5 0	0 7 0	0 9 6
13 „ 11 by 9 in.	0 6 0	0 7 9	0 10 6
14 „ 12 by 10 in.	0 6 6	0 7 9	0 12 6

2944 **Plate Boxes of Mahogany,** at a small advance on above prices (fig. 2944).

2945 **Pine Wood Grooving** for storing Negatives, per foot, 8d.

		12 Grooves.	24 Grooves.
2946	**Plate Draining Racks,** folding	£0 4 0	£0 5 0
2947	Ditto ditto large size for 12 by 10 Plates	0 6 0	0 9 6

GLASS PLATES.

Chance's Finest Patent Plate.

		s.	d.
4¼ by 3¼	per doz.	2	0
5 by 4	„	3	0
6¾ by 3¼	„ stereo	3	6
6½ by 4¾	„	4	6
7¼ by 4½	„	4	9
7½ by 5	„	5	6
8½ by 6½	„	8	5
9 by 7	„	12	0
10 by 8	„	15	6
11 by 9	„	21	6
12 by 10	„	27	6

Best Crown Glass, Cleaned.

		s.	d.
2½ by 2	per gross	2	0
3¼ by 2¾	„	3	6
4¼ by 3¼	„	7	0
5 by 4	„	11	6
6½ by 4¾	„	21	0
8½ by 6½	„	40	0
10 by 8	„	64	0
12 by 10	„	110	0

Crystal Polished Sheet.

This Glass is recommended with confidence. It is almost as flat as Patent Plate, and the same substance.

	Per doz. s.	d.	Per gross. s.	d.
4¼ by 3¼	1	0	11	0
5 by 4	1	6	17	0
6½ by 4¼	2	2	26	0
6½ by 4¾	2	6	28	0
7¼ by 4½	2	8	—	
7½ by 5	3	0	34	0
8½ by 6½	4	6	52	0
9 by 7	6	0	70	0
10 by 8	6	8	78	0
12 by 10	12	0	130	0

Best Crown Polished.

	Per doz. s.	d.	Per gross. s.	d.
2½ by 2	0	4	3	3
3¼ by 2¾	0	6	5	3
4¼ by 3¼	1	0	11	6
5 by 4	1	5	16	6
6½ by 4¾	2	4	25	6
8½ by 6½	4	4	52	0
10 by 8	9	0	87	0
12 by 10	13	0	150	0

FILTERING PAPERS.

			Each. £	s.	d.
2948	**White Filtering Paper**		0	1	6
2949	Ditto ditto extra thick, free from iron or other impurities		0	1	9
2950	**Swedish Filtering Paper**		0	4	0
2951	**Papier Joseph**		0	1	4
2952	**Drying Boards**, stout, white, 19½ by 25 in.	per quire	0	5	0
2953	**Circular Filter Papers**, in packets of 100	per ream	3	3	0

6 in., per packet, 10d.; 10 in. 1s. 4d.; 13 in. 1s. 6d.

PHOTOGRAPHIC PAPERS.

		Per Quire. £	s.	d.	Per Ream. £	s.	d.
2954	**Plain Rive Paper**, best quality	0	3	6	3	0	0
2955	**Plain Saxe Paper**, 23 by 18	0	4	0	3	3	0
2956	**Prepared Wax Negative Paper**	0	12	6	10	10	0
	New Super-Albumenized, Rive and Saxe's Papers (selected).						
2957	**Saxe's Positive Thick**	0	7	0	6	6	0
2958	Ditto ditto **Medium**	0	7	0	6	6	0
2959	**Rive's Medium**	0	6	6	6	0	0
2960	Ditto **Thick**	0	6	6	6	0	0

The various Photographic papers of English manufacture supplied to order.

IMPROVED PRESSURE, REVERSING, OR PRINTING FRAMES.

These frames are constructed that a uniform pressure may be obtained, thus insuring perfect contact between the positive paper and negative plate.

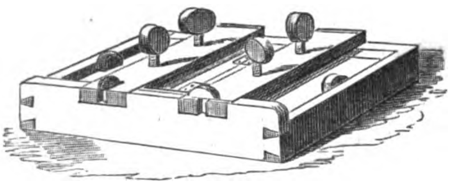


FIG. 2961.

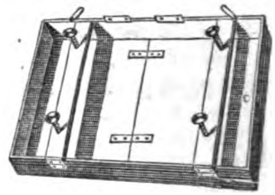


FIG. 2962.

2961 **Pressure Frames,** with jointed backs for examination whilst Printing, in Oak or French Polished Mahogany, of the best kind and make (fig. 2961):—

		Oak. Each.			Mahogany. Each.		
		£	s.	d.	£	s.	d.
No. 1 size of glass	9 by 7 in.	0	12	0	0	15	0
2 „	10 by 8 in.	0	14	0	0	16	6
3 „	11 by 9 in.	0	15	6	0	18	6
4 „	12 by 10 in.	0	17	6	1	1	0
6 „	15 by 12 in.	1	2	0	1	7	6

2962 **Pressure Frames,** of Common kind and make, with screws or springs, and hinged backboard and glass (fig. 2962):—

Size for pictures,	7 by 6 in.	9 by 7 in.	10 by 8 in.	12 by 10 in.	14 by 12 in.
Price . .	7s. 6d.	9s. 6d.	13s. 6d.	16s. 6d.	21s.

2963 **Pressure Frames,** in White Wood, Common kind, with hinged backs, without Glass:—

	s.	d.	s.	d.		s.	d.	s.	d.
For plates 4¼ by 3¼ in.	1	6	2	6	For plates 8 by 5 in.	3	0	4	6
„ 5 by 4 in.	1	6	2	6	„ 8½ by 6½ in.	3	0	4	6
„ 6½ by 4¾ in.	2	0	4	0	„ 9 by 7 in.	3	6	5	0
„ 7½ by 4½ in.	2	0	4	0	„ 12 by 10 in.	5	6	8	0

Stereoscopic 6¾ by ¾ in., 4s.

FIG. A.

FIG. B.

FIG. C.

FIG. D.

2964 **Glass Cutting or Shaping Plates,** with bevelled and polished edges. These plates are for placing over the positive paper prints before mounting, and are of four patterns—Oval, Square, Dome, and Cushion, being held firmly on to the picture. When the best position of the picture is obtained, a sharp pointed knife is run along the outer polished edge of the shape; the picture is then ready to be placed on card-board.

2965 **Glass Cutting or Shaping Plates** (figs. A B C D).

For Pictures	2½ by 2 in.	each	£0	0	6		For Pictures	6½ by 4¾ in.	each	£0	1	4
„	3¼ by 2¾ in.	„	0	0	8		„	8½ by 6½ in.	„	0	1	6
„	4¼ by 3¼ in.	„	0	0	9		„	10 by 8 in.	„	0	2	6
„	5 by 4 in.	„	0	1	0		Carte de Visite	. . .		0	0	9

2965* **Cutting Knives,** for using with above . . . . . each 0 1 0

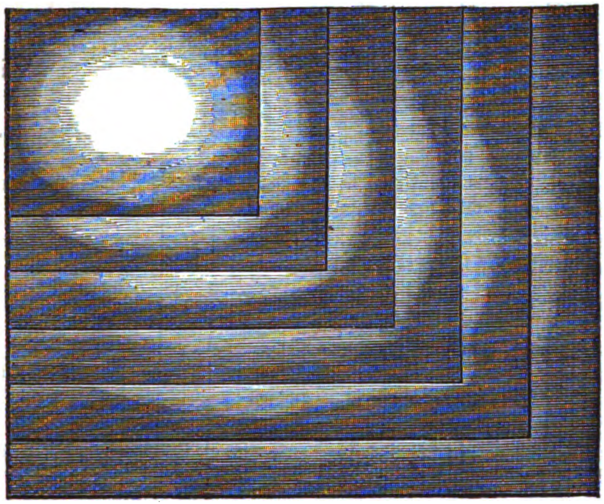


FIG. 2966.

2966 **Vignette Plates,** for Portraits or Landscapes (fig. 2966):—

Size 2½ by 2 in.	.	each	£0	0	6	Size 6½ by 4¾ in.	.	each	£0	1	10
„ 3¼ by 2¾ in.	.	„	0	0	9	„ 8½ by 6½ in.	.	„	0	2	2
„ 4¼ by 3¼ in.	.	„	0	1	0	„ 9 by 7 in.	.	„	0	2	6
„ 5 by 4 in.	.	„	0	1	6	„ 10 by 8 in.	.	„	0	3	0
Carte de Visite	.	„	0	1	0	„ 12 by 10 in.	.	„	0	4	6

Double for Stereoscopic pictures, each 2s. 4d.

2967 **Glass Rods,** for spreading solutions on to paper, 3d., 4d., 6d., 1s.
2968 **Camel Hair Brushes,** for spreading solutions on to paper, made without metal binding:—

Breadth .	1½ in.	2 in.	2½ in.	3 in.	4 in.	5 in.
Price, each	1s. 6d.	1s. 9d.	2s. 3d.	2s. 6d.	3s. 6d.	4s. 6d.

2969 Ditto, Thick Round, 1s. and 1s. 6d. each.
2970 Ditto ditto bound with Silver Wire . . . £0 2 0 £0 2 6

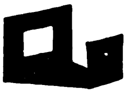


FIG. 2983.

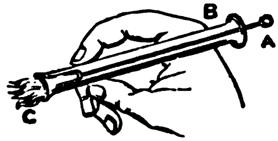


FIG. 2971.

FIG. 2981.

2971 **Buckle's Brushes** (fig. 2971), for spreading solutions on Paper; Glass Tube, B, Silver Wire Hook, A, which draws a piece of wool partly through the tube at C, price 2s.
2972 **Wood Clips**, for suspending sheets of paper to dry, 1s. per dozen.
2973 **Glass Clips**, 2s. 6d. per dozen.
2974 **Plate Cleaning Liquid**, per bottle, 1s.
2975 **India-Rubber Finger Stalls**, 6d. each.

No.	Article	Each. £ s. d.	Each. £ s. d.
2976	**Leathers** for Cleaning Glass plates, from 2s. ditto.		
2977	**Double Zinc Dish for Waxing Paper**, very convenient		0 10 6
2978	**Horn Forceps**, for manipulating with Waxed or other Paper		0 1 6
2979	**Boxwood Forceps**, for the same purpose		0 1 0
2980	**Silver Wire Hooks**, for lifting sensitive plates from dishes, from		0 2 0
2981	**Ebonite Forceps**, without rivets (fig. 2981)		0 1 9
2982	**Circular Spirit Level**, best make, for accurately levelling Cameras, or Glass Plates for developing (fig. 2982)		0 6 6
2983	**Photographic Visuometer** (fig. 2983), for enabling the tourist to judge of the effect of a landscape		0 4 6
2984	**Focusing Glass, or Eye-Piece**, for obtaining a perfectly sharp picture, see page 260. 5s. 6d., 7s. 6d.,	0 12 6	0 16 0
2985	**Magnifying Lenses** for examining Photographs, &c., of various sizes and mountings (see pages 200 and 202)		
	Instrument to count Seconds	1 10 0	2 10 0

PHOTOGRAPHIC BRUSHES.

No.	Article		£ s. d.	£ s. d.
2986	Nos. 1 and 2, **Small Camel Hair**	per dozen		0 1 6
2987	Ditto, No. 3	„		0 2 0
2988	**Sables in Quills**	each 4d.,	0 0 6	0 1 0
2989	**Miniature Brushes**	per dozen		0 4 6
2990	**Sables in Albata**, very fine		0 4 0	0 6 6
2991	**Camel Hair Dusters**	each		0 0 3
2992	**Round Camel Hair Brushes in Tin**	each 6d.,	0 1 0	0 2 6
2993	**Stumps**	each	0 0 4	0 0 6
2994	**Gold, Silver, or Alumina Shells**	„		0 1 0

2995 **Double Geared Rolling Machine, with Fly Wheel.** This is the machine for which there is the largest demand (fig. 2995):—

Size of plate, 18 by 12 in., £7; 21 by 15 in., £9 5s.; 24 by 18 in., £12.

All the above machines are supplied with burnished steel plates and metal plates.

2995* **Small Machine for Cartes de Visite** (fig. 2995*), with plate. Size of plate, 7¼ by 3¾ in. 2 2 0

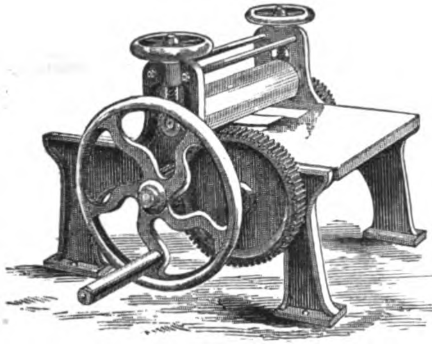


FIG. 2995.

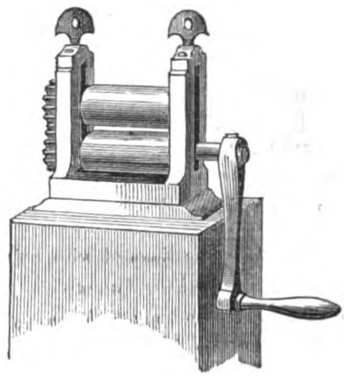


FIG. 2995*.

		Each. £ s. d.	Each. £ s. d.
2996	**Amateur's Rolling Machine.** Size of Plate, 9 by 6 in.		3 5 0
2997	**Albums** for holding Carte de Visite or Cabinet sized pictures in a variety of mountings, and of sizes to contain 10, 25, 50, 80, and 100 pictures; price, according to number to contain and finish .	0 5 0	5 5 0
2998	**Backgrounds for the Operating Room,** sizes suited for the room, painted to order:—		
	Size, 6 by 4 feet . . . . Price about	1 10 0	2 2 0
	„ 7 by 6 feet	2 2 0	3 3 0

2999 STOPPERED BOTTLES FOR CHEMICALS.

Green Glass (narrow mouth).		White Glass (narrow mouth).		White Glass (wide mouth).	
5 oz. capacity	5d.	1 oz.	4d.	1 oz.	5d.
10 „	6d.	2	6d.	2	7d.
16 „	7d.	4	8d.	4	9d.
20 „	8d.	8	9d.	8	11d.

NITRATE OF SILVER.

These prices are for Cash only, which must accompany the order, as credit cannot be given.

	Ordinary Commercial.	Fused.	Pure re-crystallised.
1 oz. and under 5	£0 4 0	£0 4 3	£0 4 6
5 „ 10	0 3 9	0 4 0	0 4 3
10 „ 25	0 3 8	0 3 10	0 4 0
25 „ 50	3 3 7	0 3 9	0 3 10

3000	**Nitrate of Silver Bath,** prepared for Positive or Negative process, inclusive of bottles . . . . per pint	£0 8 10
3001	**Nitrate of Silver Baths,** 60 grains to the oz. of Distilled Water for sensitizing albumenized paper . . . . . per pint	0 12 6

THE LIVERPOOL DRY PLATE.

PRICE LIST OF PREPARED PLATES.

Size	Ordinary or Rapid. £	s.	d.	Size	Ordinary or Rapid. £	s.	d.	Size	Ordinary or Rapid. £	s.	d.	Size	Ordinary or Rapid. £	s.	d.
4¼ by 3¼	0	4	0	6½ by 4¾	0	8	6	8 by 5	0	12	6	10 by 8	1	3	0
5 „ 4	0	5	6	7¼ „ 4½	0	10	0	8½ „ 6½	0	16	0	11 „ 9	1	8	0
6¾ „ 3¼	0	7	0	7¼ „ 5	0	11	6	9 „ 7	0	18	0	12 „ 10	1	15	0

All Plates are issued with coloured backs to prevent blurring by reflection.

Full instructions for exposing and developing accompany each package.

These Plates are admirably adapted for the production of Transparencies for Stereo. or Lantern Slides.

3002 **Hard Crystal Varnish for Collodion Negatives,** in bottles, 1s. 6d., 2s. 6d., and 4s. 6d. Per Pint, 7s.

Directions for Use.—Warm the Plate gently by the fire, and pour on the Varnish in the same manner as the Collodion, returning the superfluous quantity to the bottle; then hold the Varnished side to the fire for a few moments; the Varnish will, when cold, present a perfectly hard and even surface.

This Varnish if diluted with Alcohol (strength 62 O.P.) in the proportion of 5 ozs. of Varnish to 3 ozs. of Alcohol, will make an excellent print varnish for preserving Photographs from fading.

Directions.—Pour sufficient of the diluted Varnish into a clean dish, then immerse the print for about two minutes, remove, and when dry it is ready for mounting. A second immersion in the varnish will give the print a better surface if required.

3002° **Liquid Jet,** for applying to the back of the Collodion, Positives, giving great brilliancy and lustre to the pictures. This preparation is not liable to crack. Price, 6d. per 4 ounce bottle; 8 ounce ditto, 1s.

COLLODIONS FOR NEGATIVE AND POSITIVE PICTURES.

3003 **Thomas's Negative Collodion,** with Potassium Iodizer, Cadmium Iodizer, Bromo-Cadmium Iodizer, or Bromo-Potassium Iodizer. 1 pint 10s., ½-pint 5s.

3004 **Thomas's Positive Collodion and Iodizer,** in pints 10s., ½-pints 5s., ¼-pints 3s.

3005 **Mawson's Negative and Positive Collodion,** ¼-pints 2s. 9d., ½-pints 5s., pints 10s.

3006 **Card Mounts,** for mounting Stereoscopic paper pictures, per 100, 1s. 6d., 2s. 6d., and 5s.

3007 **Enamelled Stereoscopic Card Mounts,** per gross £0 6 6

3008 **Card Mounts,** stout, for Carte de Visite pictures, per 1,000 10s. 6d. 0 12 6

PURE CHEMICALS AND PREPARATIONS.

USED IN THE PHOTOGRAPHIC PROCESSES.

No.	Article		£ s. d.	£ s. d. Per oz.
3009	**Acid, Acetic,** Glacial	per pint, 5s., 6s.		0 0 6
3010	„ **Citric**	per lb., 5s.		0 0 6
3011	„ **Formic**			0 0 6
3012	„ **Gallic**			0 1 3
3013	„ **Hydrochloric**	per lb., 1s.		0 0 2
3014	„ **Nitric,** sp. gr. 1·450	per lb., 2s.		0 0 2
3015	„ **Pyrogallic,** pure	per drachm, 10d.		0 4 6
3016	„ **Succinic**			0 5 6
3017	„ **Sulphuric**	per lb.		0 0 3
3018	„ pure	„		0 1 6
3019	„ **Tannic**			0 1 0
3020	**Alcohol**	per pint, 4s. and 5s.		0 0 4
3021	„ **Absolute,** sp. gr. ·796	„ 7s. 6d.		0 0 6
3022	**Ammonia,** sp. gr. ·880	„ 1s. 6d.		0 0 2
3023	**Ammonium, Bromide**			0 2 0
3024	„ **Chloride**			0 0 3
3025	„ **Fluoride**			0 0 9
3026	„ **Iodide**			0 2 6
3027	„ **Sulphide**	per lb.		0 5 0
3028	**Barium, Chloride**	per lb., 2s. 6d.		0 0 3
3029	„ **Iodide**			0 3 0
3030	**Baryta, Nitrate**	per lb., 2s.		0 0 2
3031	**Benzole**	per pint		0 2 0
3032	**Bromine**			0 3 0
3033	**Cadmium**			0 4 0
3034	„ **Bromide**			0 3 0
3035	„ **Iodide**			0 2 6
3036	**Calcium, Bromide**			0 3 6
3037	„ **Iodide**			0 3 0
3038	**Charcoal, Animal**	per lb., 4s.		0 0 5
3039	**Chloroform**	„ 10s. 6d.		0 1 0
3040	**Collodions,** see previous page			
3041	**Cotton Wool**			0 0 3
3042	**Dextrine**	per lb, 1s. 3d.		0 0 2
3043	**Æther, Sulphuric,** sp. gr. ·720	„ 7s.		0 0 6
3044	„ „ „ ·750	„ 6s.		0 0 5
3045	**Æther, Sulphuric,** Methylated Spirit, sp. gr. ·720	„ 3s.		0 0 3
3046	**Glycerine,** pure distilled	„ 4s.		0 0 6
3047	**Gold Chloride,** in 15 gr. tubes ¼ drachm	each		0 2 6
3048	„ „ 30 „ ½ „			0 4 6
3049	„ „ 60 „ 1 „			0 8 6
3050	„ „ and **Soda,** non-deliquescent, neutral, 15 grs.			0 2 6
3051	**Gun Cotton** (Pyroxyline)			0 2 6
3052	„ **Paper**			0 4 0
3053	**Iodine** pure (variable)			0 2 6
3054	„ **Chloride**			0 5 6
3055	**Iron, Ammonio Citrate**	per lb.		0 5 0
3056	„ **Bromide**			0 3 0

No.	Article		£ s. d.	£ s. d. Per oz.
3057	Iron, New Developer	per lb.		0 1 0
3058	„ Saccharo Sulphate	„		0 1 6
3059	„ Iodide			0 1 6
3060	„ Protosulphate	per lb. 8d.		0 0 1
3061	Kaolin (China Clay), Washed	„ 1s.		0 0 1
3062	Lime, Bromide			0 3 6
3063	„ Cylinders, for Oxy-hydrogen Light, see No. 1616			
3064	Lead, Nitrate			0 0 3
3065	„ Acetate			0 0 3
3066	Magnesium Wire	per foot		0 0 3
3067	Mercury, Distilled	per lb., 3s. 6d.		0 0 3
3068	„ Bichloride			0 0 6
3069	Naphtha, Vegetable	per pint		0 1 3
3070	Platinum, Bichloride Solution	per dram		0 5 0
3071	Potash, Bichromate			0 0 6
3072	„ Chlorate	per lb.		0 2 6
3073	„ Nitrate	„ 1s.		0 0 1
3074	Potassium, Bromide, pure			0 1 0
3075	„ Cyanide	in 1 lb. bottles, 4s.		0 0 4
3076	„ „ in Sticks			0 0 6
3077	„ Fluoride			0 0 8
3078	„ Iodide			0 1 6
3079	Plate Cleaning Solution	per bottle	0 0 6	0 1 0
3080	Silver, Nitrate, see page 501			
3081	„ Oxide, pure			0 9 0
3082	„ Sheet and Wire			0 8 0
3083	Soda, Acetate	per lb., 2s.		0 0 2
3084	„ Hyposulphite	28 lbs., 10s. 6d., per lb.		0 0 6
3085	„ Phosphate			0 0 2
3086	Sodium, Chloride, pure			0 0 2
3087	„ Fluoride			0 1 6
3088	Sugar of Milk			0 0 8
3089	„ Grape			0 0 6
3090	Tannin			0 1 0
3091	Test Paper, Blue Litmus	per book		0 0 2
3092	„ Red			0 0 2
3093	Tripoli			0 0 3
3094	Rouge, fine			0 0 6
3095	Rottenstone, prepared			0 0 6
3096	Uranium, Nitrate			0 3 0
3097	Varnish, Amber, in Chloroform			0 1 6
3098	„ Crystal Varnish	per bottle, 4s.		0 0 4
3099	„ Black Jet	per bottle	0 0 6	0 1 0
	„ Sohnee Freres	„		0 1 9
3100	Spirit Varnish	per pint, 7s.		0 0 6
3101	Water, distilled, Chemically pure	per gallon		0 0 8
3102	White Wax	per lb.		0 3 0

These prices are subject to frequent variation.

ESTIMATES OF COMPLETE SETS OF PHOTOGRAPHIC APPARATUS FOR PORTRAITS AND VIEWS.

3103 **Complete Elementary Set of Photographic Apparatus,** for taking **Portraits** 4¼ by 3¼ inches; consisting of a sliding body camera; one single back, for plates 4¼ by 3¼ inches, fitted with compound achromatic Portrait lens printing frame; glass plates in box; bath and dipper; porcelain washing pans; scales and weights; glass graduated measure; filter paper and funnel; positive paper, for printing; tripod stand, and Chemicals; complete, in case, with lock and key £5 5 0

3104 **Complete Set of Photographic Apparatus,** for **Portraits** 4¼ by 3¼ inches, same as No. 3103, but with superior Lens, and **Central Stops,** and a best Camera packed in Case £8 10 0

3105 **Complete Set of Photographic Apparatus,** best, for plates 5 by 4 inches, and 4¼ by 3¼ inches; Compound Achromatic Portrait Lens, with **Central Stops;** with all the necessary apparatus, chemicals, papers, tripod stand, &c.; packed in case, with lock and key £10 10 0

3106 **Complete Set of Photographic Apparatus,** for plates 6 by 5 inches, 5 by 4 inches, and 4¼ by 3¼ inches, as No. 3105; tripod stand, with all requisite apparatus, chemicals, and materials; packed in case, with lock and key. £14 14 0

3107 **Complete Set of Apparatus for Collodion Pictures,** 8½ by 6½ inches, 6 by 5 inches, and 5 by 4 inches; comprising a best sliding body camera, with one dark slide, and three loose frames for Glass Plates, focusing glass, &c., best combination achromatic Portrait lens, with **Central Stops,** a full supply of chemicals, apparatus and materials, tripod stand, &c., complete; packed in case, with lock and key £27 0 0

3108 **Complete Set of Apparatus,** consisting of a best sliding body camera, and Combination Lens, applicable for taking Cabinet and Carte de Visite Portraits or Views, on plates 6½ by 4¾ inches, with tripod stand, scales and weights, three porcelain pans, bath, printing frame, three boxes of glass plates, funnels, glass measures, developing cups, albumenized paper, with a good supply of chemicals; packed in a box with lock and key £12 12 0 £14 14 0

3109 **Apparatus** for producing Collodion Views by either the Wet or Dry process, size 9 by 7 inches; consisting of a Kinnear's Folding Camera, fitted with one of Negretti and Zambra's **Landscape Lenses,** tripod stand, reversing frame, scales and weights, three porcelain pans, Glass bath and Dipper, two funnels, two graduated measures, one dozen plates in box, albumenized paper, filtering ditto, levelling stand, and a full supply of chemicals; packed in case, with lock and key £18 10 0

3110 Ditto ditto for 10 in. by 8 in. pictures £21 10 0

3111 **Apparatus** for the production of Collodion Views, size 11 by 9 inches, consisting of Kinnear's Folding Camera, fitted with one of Negretti and Zambra's **Landscape Lenses,** apparatus, &c., and a full supply of chemicals: the whole packed in case, with lock and key . . £25 0 0

3112 Ditto ditto for 12 in. by 10 in. pictures £31 0 0

Estimates furnished for larger sets of Apparatus.

APPENDIX.

BINOCULAR VISION AND THE STEREOSCOPE.*

An object is said to be "stereoscopic" (from Greek words signifying *solid* and *I see*) when it stands out in relief, and gives to the eye the impression of solidity.

This subject was first explained by Professor Wheatstone in a memoir on binocular vision, published in the *Philosophical Transactions* for 1838; in which he shows that solid bodies project different perspective figures upon each retina, and that the illusion of solidity may be artificially produced by means of the "Stereoscope."

The phenomena of binocular vision may be simply stated as follows: If a cube or a small box of an oblong form be placed at a short distance in front of the observer, and viewed attentively with the right and left eye separately and in succession, it will be found that the figure perceived in the two cases is different; that each eye sees more of one side of the box, and less of the other; and that in neither instance is the effect exactly the same as that given by the two eyes employed conjointly.

The diagrams on the Fig. c, page 50, exhibit the appearance of a cube as seen by each eye successively. The figure being supposed to be placed about seven inches immediately before the spectator.

The human eyes are placed at 2½ inches, or from that to 2¾ inches asunder; hence it follows that, the points of sight being separated, a *dissimilar* image of a solid object is formed by each eye. We do not, however, see *two* images, but a single one, which is stereoscopic.

In looking at a picture painted on a flat surface the case is different; the eyes as before, form two images, but these images are in every respect similar; consequently the impression of solidity is wanting. A single picture, therefore, cannot be made to appear stereoscopic. To convey the illusion *two* pictures must be employed, the one being a right and the other a left perspective projection of the object. The pictures must also be so arranged, that each is presented to its own eye, and that the two appear to proceed from the same spot.

The reflecting stereoscope employed to effect this, forms *luminous images* of the binocular pictures, and throws these images together, so that, on looking into the instrument, only a single image is seen, in a central position. It should, however, be understood that no optical arrangement of any kind is indispensably required, since it is quite possible, with a little effort, to combine the two images by the unaided organs of vision.

In Mr. Wheatstone's Reflecting Stereoscope (see fig. 1232, page 265), *mirrors* are used. The principle of the instrument is as follows: objects placed in front of a mirror have their reflected images apparently *behind* the mirror. By arranging two mirrors at a certain inclination to each other, the images of the double picture may be made to approach until they coalesce, and the eye perceives a single one only. The reflecting Stereoscope is adapted principally for viewing large pictures. The refracting Stereoscope is a much more portable and convenient form of Instrument, invented by Sir David Brewster. A sectional view of the common form is given in the diagram (fig. 1209, page 262), in which the observer looks directly at the drawings instead of at the reflected images.

The brass tubes to which the eyes of the observer are applied to contain each a

* Abridged from Hardwich's *Manual*.

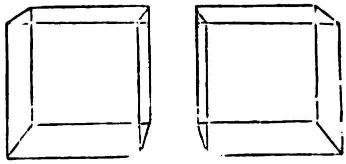


FIG. C.

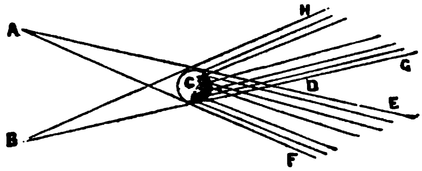


FIG. H*.

semi-lens, formed by dividing a common lens through the centre, and cutting each half into a circular form. The half-lens viewed in section (fig. 1209) is therefore of a prismatic shape, and when placed with its sharp edge as in the diagram (fig. 1209), alters the direction of the rays of light proceeding from the picture, bending them outwards or away from the centre, so that in accordance with well-known optical laws they appear to come in the direction of the dotted lines in the diagram (fig. 1209), and the twoimages coalesce at their point of junction. In the instrument as it is often sold, one of the lenses is made movable, and by turning it round with the finger and thumb it will be seen that the positions of the images may be shifted at pleasure.

Stereoscopes are now mostly mounted with whole lenses in place of the semi-lenses above described. In such cases the images coalesce by an involuntary action of the eyes of the observer. If indeed the whole lenses were set wider apart than 2½ inches, it might be conjectured that vision would take place principally through the inside edges, and that the same effect as that of a semi-lens would be produced. A single experiment, however, will suffice to show that even when the centres of the lenses are exactly opposite to the eyes, the two pictures combine without any effort. We quote the following from Professor Wheatstone's paper :—

"It will now be obvious why it is impossible for the artist to give a faithful representation of any near solid object, that is, to produce a painting which shall not be distinguished in the mind from the object itself. When the painting and the object are seen with both eyes, in the case of the painting two *similar* pictures are projected on the retinæ, in the case of the solid object the pictures are *dissimilar;* there is, therefore, an essential difference between the impressions on the organs of sensation in the two cases, and consequently between the perceptions formed in the mind; the painting, therefore, cannot be confounded with the solid object.

"After looking over the works of many authors who might be expected to have made some remarks relating to this subject, I have been able to find but one, which is in the *Trattato della Pittura* of Leonardo da Vinci.* This great artist and ingenious philosopher observes, 'that a painting, though conducted with the greatest art, and finished to the last perfection, both with regard to its contours, its lights, its shadows, and its colours, can never show a relievo equal to that of the natural objects, unless these be viewed at a distance and with a single eye.' 'For,' says he, 'if an object C (fig. H*) be viewed by a single eye at A, all objects in the space behind it, included as it were in a shadow ECF cast by a candle at A, are invisible to the eye at A; but when the other eye at B is opened, part of these objects become visible to it: those only being hidden from both eyes that are included, as it were, in the double shadow CD, cast by two lights at A and B, and terminated in D, the angular space EDG beyond D being always visible to both eyes. And the hidden space CD is so much the shorter, as the object C is smaller and nearer to the eyes. Thus the object C seen with both eyes becomes, as it were, transparent, according to the usual definition of a transparent thing; namely, that which hides nothing beyond it. But this cannot happen when an object, whose breadth is bigger than that of the pupil, is viewed by a single eye.

* See also a *Treatise of Painting*, p. 178, London, 1721; and Dr. Smith's *Complete System of Optics*, vol. ii., p. 244, where the passage is quoted.

The truth of this observation is therefore evident, because a painted figure intercepts all the space behind its apparent place, so as to preclude the eyes from the sight of every part of the imaginary ground behind it.'

"Had Leonardo da Vinci taken, instead of a sphere, a less simple figure for the purpose of his illustration, a cube, for instance, he would not only have observed that the object obscured from each eye a different part of the more distant field of view, but the fact would also, perhaps, have forced itself upon his attention, that the object itself presented a different appearance to each eye. He failed to do this, and no subsequent writer within my knowledge has supplied the omission; that two obviously dissimilar pictures are projected on the two retinæ when a single object is viewed, while the optic axes converge, must therefore be regarded as a new fact in the theory of vision.

"Every one must be aware how greatly the perspective effect of a picture is enhanced by looking at it with only one eye, especially when a tube is employed to exclude the vision of adjacent objects, whose presence might disturb the illusion. Seen under such circumstances from the proper point of sight, the picture projects the same lines, shades, and colours on the retina as the more distant scene which it represents would do were it substituted for it. The appearance which would make us certain that it is a picture is excluded from the sight, and the imagination has room to be active. Several of the older writers erroneously attributed this apparent superiority of monocular vision to the concentration of the visual power in a single eye.*

For description and prices of Stereoscopes, and of Negretti and Zambra's series of Stereoscopic Views on glass and paper, see pages 262 to 266, figs. 1219 and 1225, being the most perfect and convenient forms of the Stereoscope.

* "We see more exquisitely with one eye shut than with both, because the vital spirits thus unite themselves the more, and become the stronger: for we may find by looking in a glass whilst we shut one eye, that the pupil of the other dilates."—Lord Bacon's Works, *Sylva Sylvarum*, art. Vision.

TABLE SHOWING THE REDUCTION OF GRAMMES INTO GRAINS.

Grammes.		Grains.
1	equal to	15·432
2	,,	30·864
3	,,	46·296
4	,,	61·728
5	,,	77·160
6	,,	92·592
7	,,	108·024
8	,,	123·456
9	,,	138·883
10	(Decagramme)	154·323
100	(Hectogramme)	1543·234
1000	(Kilogramme)	15432·348

The *gramme* is the French unit of weight.

A Troy ounce is equal to 31·103 *grammes*.

An Avoirdupois ounce = 28·356 *grammes*.

TABLE SHOWING THE REDUCTION OF CUBIC CENTIMETRES INTO MINIMS.

Cubic. Centimetres.		Minims.
1	equal to	16·896
2	,,	33·792
3	,,	50·688
4	,,	67·584
5	,,	84·480
6	,,	101·576
7	,,	118·272
8	,,	135·168
9	,,	152·064
10	,,	168·960
20	,,	337·920
30	,,	506·880
40	,,	675·840
50	,,	844·800
100	,,	1689·600
1000	= 1 litre, or 1·76 pint	16896·000

A cubic *centimètre* is the unit of French liquid measure; 1,000 cubic *centimètres* being equal to 1 *litre*, or 1·76 pint = 35¼ fluid ounces. A cubic *centimètre* of water measures nearly 17 minims: it weighs 1 *gramme*, or 15·4 grains.

A cubic inch is equal to 16·386 cubic *centimètres*, a gallon = 4·543 *litres*.

DEEP-SEA THERMOMETERS.*

Although only recently the subject of Deep-Sea Sounding has been prominently brought before the scientific world by the investigation of Dr. Carpenter, Dr. W. Thompson, and others, yet as far back as the year 1857 the late Admiral R. FitzRoy devoted much attention to this branch of ocean investigation. The late Admiral was most anxious to obtain a thermometer which should be perfectly trustworthy in its indications under any pressure, consequent on its being used at great depths for Deep-Sea Soundings; that this Instrument was required by the Meteorologic Office was a fact well known to all meteorological instrument makers, and indeed from the rapid strides that ocean Telegraphy was making, it was necessary that the *correct* temperature at various depths of the ocean should be ascertained, and therefore it was imperative to invent a thermometer whose indications should be absolutely reliable under a pressure of even four or five tons to the square inch.

At the invitation of the late Admiral FitzRoy, various forms of thermometers were submitted to him, but it was found that no joints however well made, or cases no matter how strong, could resist the enormous pressure of the ocean at depths in which it was necessary to lower the instruments, and for awhile it was almost thought that an instrument fulfilling the conditions required could not be constructed.

Many were the experiments tried, till at length, in the year 1857, we made a thermometer whose bulb was hermetically enclosed within an outer cylinder of glass, and this outer glass of such thickness that it was quite capable of resisting even greater pressure than was required; it was perfectly manifest that this thermometer would fulfil the conditions required: this thermometer we submitted to the late Admiral FitzRoy, who at different times ordered about fifty for public service.

The Thermometer, which we called the Double Bulb Deep-Sea Thermometer, was invented by us as above stated, in the year 1857, and a notice of it was published in the first number of the Meteorological Papers for that year; it will therefore be a matter of surprise to the reader to learn that this identical thermometer, identical in every respect (except its size), has been, after a lapse of some twelve years, *re-invented*, and ushered in before the scientific world with all the prestige of having a paper read upon it by the Vice-President of the Royal Society, Dr. Miller, who declared that he had just invented the instrument, in which task of inventing (an instrument well known to all leading instrument makers) the learned Doctor says he was assisted by Mr. Casella (see "Proceedings Royal Society," No. 113, page 482).

* *A Pamphlet containing the complete history of the Deep-Sea Thermometer will be forwarded by post upon application to Negretti and Zambra* See ante, pages 148 and 149.

Annexed is an extract from the above paper, describing the instrument, and by its side we give an extract from a treatise published by us in the year 1864, called "A Treatise on Meteorological Instruments."

Extract from "THE PROCEEDINGS OF THE ROYAL SOCIETY," Vol. xvii., Page 483. Paper read June 3rd, 1869.

"The expedient adopted for protecting the thermometer from the effects of pressure consisted simply in enclosing the bulb of such a Sixe's thermometer in a second of outer glass tube, which was fused upon the stem of the instrument. This outer glass tube was nearly filled with alcohol, leaving a little space to allow of variation in bulk due to expansion.

"The spirit was heated to displace part of the air by means of its vapour, and the outer tube and its contents were sealed hermetically."

Extract from "NEGRETTI & ZAMBRA'S TREATISE ON METEOROLOGICAL INSTRUMENTS." Published 1864. Page 90.

"The thermometers constructed by Messrs. Negretti and Zambra for this purpose do not differ materially from those usually made under the denomination of Sixe's thermometer, except in the following *important particular* :—

"The usual Sixe's thermometers have a central reservoir or cylinder containing alcohol; this reservoir, which is the only portion of the instrument likely to be affected by pressure, has been in Negretti and Zambra's new instrument superseded by a strong outer cylinder of glass, containing mercury and rarefied air; by this means the portion of the instrument susceptible of compression has been so strengthened that no amount of pressure can possibly make the instrument vary."

It will be apparent on reading the foregoing extracts that the principle of the two instruments is identical; this fact we communicated to the late Dr. Miller as soon as it came to our knowledge that he had read a paper at the Royal Society on his supposed invention. Dr. Miller in his reply to us stated that he was not aware that such an instrument had been previously constructed; this point we conceded to Dr. Miller, but told him at the same time that such a plea could not possibly be set up by his coadjutor and maker of the instrument, and whose name was and is now mentioned as the inventor, as he was perfectly cognisant of the existence of our instrument, as were also all connected with the trade. We freely acquit Dr. Miller of collusion, and believe he acted *bona fide*, and we believe also that he was only led up to re-invent an old thermometer, which was invented by ourselves and no one else, upwards of twelve years previously. One thing we will assert, and that is, that neither Dr. Miller nor his assistant inventor of the now celebrated Deep-Sea Thermometer would have dared to exhibit the thermometer as a novelty before the Royal Society, had Admiral FitzRoy been alive. As we do not wish to put forward the foregoing statement unsupported by disinterested evidence, we beg to call the reader's attention to the annexed extract from "THE QUARTERLY JOURNAL OF THE METEOROLOGICAL SOCIETY, for *January* 17, 1872," Vol i., No. 2, Page 49.

PAPER BY

ROBERT H. SCOTT, F.R.S.

(FROM QUARTERLY JOURNAL OF THE METEOROLOGICAL SOCIETY, JAN. 17TH, 1872.)

"DEEP-SEA THERMOMETERS.

"*Prepared under Admiral FitzRoy's Superintendence.**

"In a paper by Capt. J. E. Davis, R.N., '*On Deep-Sea Thermometers*,' which has been printed in Vol. v. of the 'Proceedings,' it is stated (page 309) that 'at a Meeting of the Committee of the Royal Society, held in the Hydrographer's Room in April, 1869, and at which all the appliances for deep-sea sounding were placed before them, the plan of operation for testing the thermometers was discussed. . . . . At the time these experiments were proposed, it was not known that a thermometer had been constructed at the suggestion of Mr. Glaisher,† by the late Admiral FitzRoy's directions, with the view of removing the difficulty of pressure.'

"The author gives a reference to a notice of the instruments in question, which is to be found in the first Number of 'Meteorological Papers,' published by authority of the Board of Trade in 1857,‡ and states that some of them had been used for deep-sea purposes.

§ "I may, perhaps, be excused if I venture to remark that, in April, 1869, the history of these instruments was perfectly familiar to many gentlemen interested in the question of deep-sea soundings.

"The number of the thermometers of this particular pattern, which was supplied to the Meteorological Department of the Board of Trade by Messrs. Negretti & Zambra, the makers, was upwards of fifty, and they were supplied to several ships in the Royal Navy, especially those employed on certain well-known deep-sea sounding expeditions; among these I may name H.M.S.

Cyclops,	Porcupine,	Swallow,
Hydra,	Serpent,	Archer,
Medina,	Gorgon,	Woodlark,
Fox,	Rifleman,	Tartarus.
Bulldog,	Firefly,	

I was not able to find any record of any of these thermometers having been tested in an hydraulic press, and, accordingly, as soon as the Miller pattern thermometer had been definitely adopted by the Hydrographer, it was resolved to subject one of the old thermometers (Negretti & Zambra's) in the Meteorological Office to the same test as that which the new instruments were made to undergo, in order to see whether or not the construction of the original instruments offered sufficient security against alteration of the shape of the bulb, owing to pressure.

"The experiments were carried out on the 28th of September, 1869, at Mr. Casella's, in the presence of Capt. Toynbee and Mr. Strachan, and the results of the testing have been published in the report of the Meteorological Committee of the Royal Society for 1869.

"The concluding sentence of that notice was as follows (page 32) :—

"'The foregoing experiments are sufficient to show that the original thermometers described by Admiral FitzRoy‖ were good and trustworthy instruments, in so far as regards their capability of resisting pressure.'"

* Admiral FitzRoy's superintendence consisted in ordering that the thermometers should be of a certain *size* and *weight*, so that they should sink easily.

† Mr. Glaisher's suggestion was that a good and trustworthy thermometer was very desirable.

‡ This reference is quoted by the author of the paper as "Meteorological Report, No. 1, 1857."

§ Dr. Miller's paper on the Casella-Miller Deep Sea Thermometer was read in June, 1869.

‖ These were Negretti & Zambra's, as already stated.

NEGRETTI & ZAMBRA'S

NEW PATENT

STANDARD DEEP-SEA THERMOMETER.*

"The most successful deep-sea thermometer hitherto has been Sixe's Thermometer, with the bulb protected from pressure, as invented by NEGRETTI AND ZAMBRA in 1857. Nevertheless there are several disadvantages inherent in the principle of construction of Sixe's instrument. The indices are unreliable, as, however carefully fitted, they m.y slip down by gravity, and even shift upward by sudden lifting motion; so that the observations are always more or less liable to error: the index error also is very liable to alter by the shifting of the spirit, or by bubbles of spirit getting among the mercury; and unless the observer is well-trained in its management, and takes care to compare it with a correct ordinary thermometer every time it is used, there is no guaranteeing its accuracy of indication. Further, its accuracy in its best condition does not attain to fractions of a degree, as it cannot be read off closer than about half a degree. Then it must be kept in the vertical position, or it is certain to become more or less deranged in transit.

"However, so long as it sufficed to observe the nearest degree of temperature, the improved protected Sixe's answers the purpose of a deep-sea thermometer, with careful management and checking; but lately the bottom temperature of shallow seas and of rivers has come under investigation, and for this purpose the Sixe's instrument is unsuitable.

"Between the temperature of the surface of the sea and that at the depth of a few fathoms, the differences to be determined are found to be not degrees of the thermometer, but *fractions* of a degree; hence, the observations to be worth anything at all, must be made with an undoubtedly accurate thermometer.

"During the last two or three years systematic observations of the surface and bottom temperatures have been taken from the various lightships off the British coasts, under the direction of the Meteorological Office. This investigation of the temperatures of the British seas has been urged upon the Government by naturalists and physicists interested in the question of the food supply of the people as affected by the take of fish. What is required to be made evident is, whether any, and what, effect temperature has upon the habits and migrations of fish, so as to tend to a right understanding of the conditions favourable for the development of the various species of fish, and the best seasons and temperature indications for their capture. This investigation, commenced with Sixe's Thermometers, has at present only shown that such instruments are not sufficiently reliable for the purpose; and it was represented by the Government to Messrs. NEGRETTI AND ZAMBRA, that a more perfect and stable deep-sea thermometer was a desideratum. They accordingly turned their attention to the matter, and the result is the new STANDARD DEEP-SEA THERMOMETER.

"The construction of this thermometer will be readily understood by reference to the sketch diagram fig. 8. The bulb is cylindrical, and mercury is the thermometrical fluid. The neck of the bulb is contracted in a peculiar manner at A, and upon the shape and fineness of this contraction the success of the instrument mainly depends. Beyond A the tube is bent, and a small catch reservoir is formed at B, for a purpose to be presently explained. At the end of the tube a small receptacle, C, is provided. When the tube is downward, the glass contains sufficient mercury to fill the bulb, tube, and a part of the reservoir C, if the temperature is high, leaving sufficient space in C for the expansion of the mercury. In this position no scale would be possible, as the apparent movement of the mercury would be confined to the space C. When the thermometer is held bulb upward, the mercury breaks of at A, but by its own weight flows down the tube, filling C and a portion of the tube above C, in relation to the resisting temperature. The scale accordingly is made to read upwards from C. To set the instrument for observation it is only necessary to place it bulb downward, then the mercury takes the temperature just as an ordinary thermometer. When at any time or at any place the temperature is required, all that has to be done is to turn the thermometer bulb upward, and keep it in this position until read off.

* Description condensed from "ENGINEERING," March 22nd, 1878.

DESCENDING.

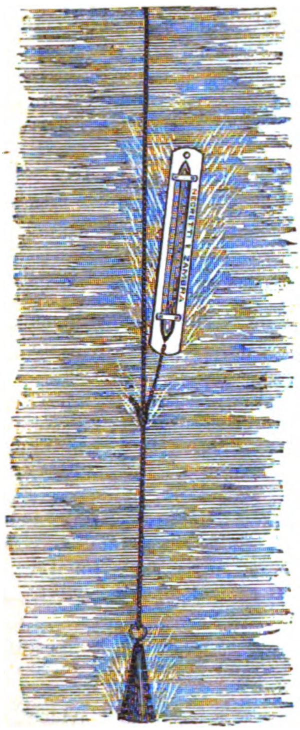


FIG. 1.

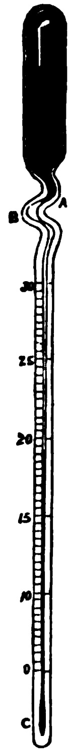


FIG. 3.

ASCENDING.

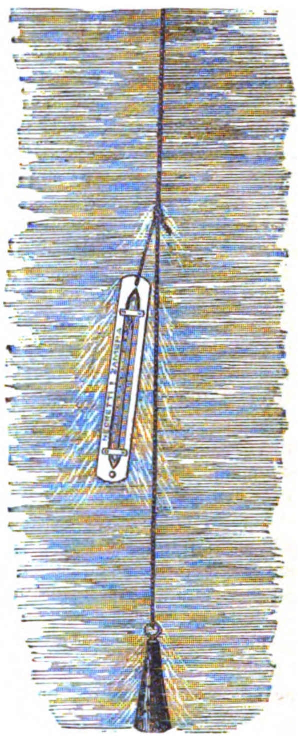


FIG. 2.

"The reading may be taken at any time after, for the quantity of mercury in the lower part of the stem which gives the reading, is too small to be sensibly influenced by a change of temperature, unless it is very great, while that in the bulb will continue to contract with greater cold and to expand with greater heat, and in the latter case some mercury will pass the contraction A, and may fall down and lodge at B, but it cannot go further so long as the bulb is upward, and thus the temperature to be read off will not be vitiated. Now, whenever the thermometer can be handled, it can readily be turned bulb upward for reading off the existing temperature. It must be clearly understood that the thermometer is only intended to give the temperature at the time and place when and where it is turned over; it is simply a recording thermometer, it cannot be used as a self-registering maximum or a minimum, though it could be constructed to act as a maximum if required. But, at a depth in the sea, some contrivances must be provided for turning the thermometer bulb upward. For this purpose the thermometer is fitted into a wooden frame, loaded with shot, free to move from end to end of it, and heavy enough to render the whole instrument just buoyant in sea-water.

"In using the thermometer a cord is rove through the hole in the frame *nearest* the bulb, and the instrument is fastened by this cord to the sounding line. In descending the thermometer will be pulled down with the bulb downwards; but upon being pulled up, the instrument, owing to the resistance through the water, and consequent displacement of its centre of gravity, will turn over and come up bulb uppermost, the temperature of the spot where it turned over will then be indicated, as shown in the illustrations. See figure 2.

"As regards the thermometer itself it was necessary, in order to make it perfectly satisfactory, to protect it against pressure, even if intended for shallow seas, as well as for

the deepest. For whether used in deep or shallow water, unless withdrawn from pressure, its indications would always be more or less in error. Like an ordinary thermometer it is devoid of air, and so quite different from Sixe's, which, containing compressed air, has a certain internal resistance. Hence it would be more affected by pressure than Sixe's, however thick the glass of the bulb. By the simple expedient of placing the thermometer entirely in a shield of glass hermetically sealed, the effect of external pressure is entirely eliminated. The shield must of course be strong. It need not be exhausted of air. It must, however, render the enclosed thermometer more difficult to be affected by changes of temperature ; in other words, it will make it sluggish.

"To counteract this sluggishness, in that portion of the shield surrounding the bulb, some mercury is introduced, and confined there by a partition cemented in the shield around the neck of the thermometer bulb. This mercury acts as a carrier of heat from the exterior of the shield to the interior of the thermometer : and the efficacy of this arrangement has been experimentally determined, the instrument thus protected being, in fact, far superior in sensibility to Sixe's thermometer.

"So long as the shield withstands the pressure, that is, does not break, the thermometer will be unaffected by pressure, and there is abundant experience to show that such a shield will stand the pressure of the deepest ocean. The greatest pressure can never affect a thermometer so protected. Doubtless the shield will be compressed a little under great pressure, but this can never exert an internal pressure sufficient to have an appreciable effect upon the thermometer. This method of shielding is quite efficacious, and deep-sea thermometers so protected do not require to be tested for pressure in the hydraulic press. The thermometer will simply require to be tested for sensitiveness and for errors of graduation very accurately ; because it is a standard instrument adapted to determine very small differences of temperature as well as large ones, even one or two-tenths of a degree in shallow waters. The test for sensitiveness should determine how many seconds the instrument requires to take up a change of 5 deg. rise or fall ; and the time has been found from 5 to 10 seconds.

"A considerable number of these instruments have already been tested at the Kew Observatory with perfectly satisfactory results, which place beyond doubt their value as Standard Deep-Sea Thermometers.

"Thus, provided the turning-over gear is found to answer, this instrument evidently possesses great advantages. It has no attached scale, the figuring and graduations being distinctly marked on the stem itself, and the shield effectually preserves them from obliteration by sea-water. The part of the stem which forms the background to the graduations is enamelled white,* to give distinctness to the mercury.

"The hole at the *top* of the frame is for the purpose of lowering and keeping the thermometer upright until it has reached the water. This is effected by putting a cord through the hole and both ends of it kept in the hand until the thermometer has reached the water, then one end is let go and the cord pulled on board ; this operation is *not* imperative, but it saves the thermometer from being knocked about previous to reaching the water."

Concise Instructions for use are sent with each Instrument.

Price for Negretti and Zambra's New Patent Standard Deep-Sea Thermometer . £2 10 0

* *Enamelling the back of Thermometer Tubes is an important invention by Negretti and Zambra. Most of the extremely sensitive Thermometers that are now made (such as Clinical Thermometers) would have been almost useless but for this improvement.*

Sea Water freezes 28°, Boils at 213·2 ; variable with the density.

80 miles from the Island of St. Thomas, at a depth of 3·875 fathoms, the temperature of the Sea was found to be 34½° Fahrenheit ; the pressure at this depth 4¼ tons to square inch.

The pressure at 100 feet is found by Divers difficult to bear for any lengthened period. Man cannot sustain a greater pressure than 6 Fathoms, or 120 feet. Weights of 6 or 8 hundredweight require two Hours to fall through 3 miles of Sea Water, owing to the friction of the water on the rope or wire.—Dr. CARPENTER.

WEIGHTS AND MEASURES OF THE BRITISH PHARMACOPŒIA, 1867.

Weights.

1 Grain	gr.		
1 Ounce	oz.	=	437·5 Grains.
1 Pound	lb.	=	16 Ounces or 7,000 Grains.

Measures of Capacity.

1 Minim	Min.		
1 Fluid Drachm .	fl. drm. . .	=	60 Minims.
1 Fluid Ounce . .	fl. oz. . . .	=	8 Fluid Drachms.
1 pint O . . .	=	=	20 Fluid Ounces.
1 Gallon C . .	=	=	8 Pints.

Measures of Length.

1 Line	=	$\frac{1}{12}$ Inch
1 Inch	=	$\frac{1}{39\cdot1393}$ Seconds Pendulnm.
12 Inches	=	1 Foot.
36 Inches	=	3 Feet = 1 Yard.

Length of Pendulum, vibrating seconds of mean time in the latitude of London, in a vacuum at the level of the sea, 39·1393 inches.

Relation of Measures to Weights.

1 Minim is the measure of		0·91	Grains of	Water.
1 Fluid Drachm . . .		54·68	„	„
1 Fluid Ounce .	1 Ounce or	437·5	„	„
1 Pint . .	1·25 Pounds or	8750·0	„	„
1 Gallon . .	10 Pounds or	70,000·0	„	„

WEIGHTS AND MEASURES OF THE METRICAL SYSTEM.

1 Milligramme = the thousandth part of one gramme, or 0·001 gramme.
1 Centigramme = the hundredth part of one gramme, or 0·01 gramme.
1 Decigramme = the tenth part of ditto, 0·1 gramme.
1 Gramme = weight of a cubic centimetre of water at 4° Centigrade.
1 Decagramme = ten grammes, 10·0.
1 Hectogramme = one hundred grammes 100·0.
1 Kilogramme = one thousand grammes 1000·0.

Measures of Capacity.

1 Millilitre =	1 cub., centim., or the meas. of		1 gramme of water.	
1 Centilitre =	10 ditto	ditto, or	10 ditto	ditto.
1 Decilitre =	100 ditto	ditto, or	100 ditto	ditto.
1 Litre =	1000 ditto	ditto, or	1000 ditto	ditto,—1 kilometre.

Measures of Length.

1 Millimetre = the thousandth part of one metre, or 0·001.
1 Centimetre = the hundredth ditto ditto, or 0·01 metre.
1 Decimetre = the tenth ditto ditto, or 0·1.
1 Metre = the ten-millionth part of a quarter of the meridian of the earth.

RELATION OF THE WEIGHTS OF THE BRITISH PHARMACOPŒIA TO THE METRICAL WEIGHTS.

1 Pound	=	453·5925 Grammes.
1 Ounce	=	28 3495 „
1 Grain	=	0·0648 „

RELATION OF MEASURES OF CAPACITY OF THE BRITISH PHARMACOPŒIA TO THE METRICAL MEASURES.

1 Gallon	=	4·543487 litres.
1 Pint	=	0·567936 litres, or 567·936 cubic centimetres.
1 Fluid Ounce . .	=	0·028396 litres, or 28·396 „ „
1 Fluid Drachm . .	=	0·003549 litres, or 3·549 „ „
1 Fluid Minim . .	=	0·000059 litres, or 0·059 „ „

RELATION OF THE METRICAL WEIGHTS TO THE WEIGHTS OF THE BRITISH PHARMACOPŒIA.

1 Milligrame	=	0·015432 Grains.
1 Centigramme	=	0·15432 „
1 Decigramme	=	1·5432 „
1 Gramme	=	15·432 „

1 Kilogramme = 2 lbs. 3 oz., 119·8 grains, or 15432·348 „

RELATION OF THE METRICAL MEASURES TO THE MEASURES OF THE BRITISH PHARMACOPŒIA.

1 Millimetre	=	0·03937 Inches.
1 Centimetre	=	0·39371 „
1 Decimetre	=	3·93708 „
1 Metre	=	39·37079 „ or one yard 3·7 inches.
1 Cubic Centimetre	=	15·432 grain measures.

1 Litre = 1 pint 15 oz. 2 drachms 11 minims, or 15432·348 grain measures.

TABLE FOR REDUCING ENGLISH FEET TO FRENCH METRES, AND FRENCH METRES TO ENGLISH FEET.

1 French Metre = 3·2808992 English Feet.

Metres or Feet.	English Feet and Decimal Parts.	French Metres and Decimal Parts.	Metres or Feet.	English Feet and Decimal Parts.	French Metres and Decimal Parts.
1	3·281	0·305	75	246·067	22·860
5	16·404	1·524	80	262·472	24·383
10	32·809	3·048	85	278·876	25·907
15	49·213	4·572	90	295·281	27·432
20	65·618	6·096	95	311·685	28·956
25	82·022	7·620	100	328·090	30·479
30	98·427	9·144	200	656·180	60·959
35	114·831	10·668	300	984·270	91·438
40	131·236	12·192	400	1312·360	121·918
45	147·640	13·716	500	1640·450	152·397
50	164·045	15·240	600	1968·539	182·877
55	180·449	16·764	700	2296·629	213·356
60	196·854	18·288	800	2624·719	243·835
65	213·258	19·812	900	2952·809	274·315
70	229·663	21·336	1000	3280·899	304·794

APPROXIMATE HEIGHT DUE TO BAROMETRIC PRESSURE.

Inches.	Feet.	Inches.	Feet.	Inches.	Feet.
31·0	0	24·5	6152	17·5	14349
30·9	84	24·0	6691	17·0	15707
—5	425	23·5	7242	16·5	16487
30·0	857	23·0	7803	16·0	17292
29·5	1296	22·5	8378	15·5	18122
29·0	1743	22·0	8966	15·0	18979
28·5	2198	21·5	9567	14·5	19865
28·0	2661	21·0	10182	14·0	20783
27·5	3132	20·5	10812	13·5	21734
27·0	3612	20·0	11458	13·0	22720
26·5	4100	19·5	12120	12·5	23746
26·0	4598	19·0	12799	12·0	24813
25·5	5106	18·5	13496	11·6	25700
25·0	5623	18·0	14212		

The English Standard of Length is the British Imperial Yard, which is the space included between two points of a certain Metal Bar when at the temperature of 60° Fahrenheit, or 15·5° Cent. A foot which is the third part of this yard, is the unit generally employed.

A Metre, the French Standard of Length, is equivalent to the ten-millionth part of the Arc of the Meridian, extending from the Equator to the Pole.

"The Germans indicate inches by putting two accents after the number; lines by putting three accents. 27″ 3‴·85, means 27 inches 3 lines 85 hundredths of a line; more frequently they give the height in lines, and the preceding number becomes 327‴·85." —*Kaemtz.*

COMPARATIVE TABLE OF ENGLISH AND FRENCH WEIGHTS AND MEASURES.

	Grains.
1 Drachm Avoirdupois . .	27·343
1 Pound Troy	5760
1 Ounce „	480
1 Drachm „	60

Myriagramme (10,000 grammes), 321⅜ Troy or 22·057 lbs. Avoirdupois.

Kilogramme (1000 grammes) 32⅛ oz. Troy or 2·2057 lbs. Avoirdupois.

Kilometre (1000 metres) 1093·63 yards, or 0·62138 miles.

Myriametre (10,000 metres) 10936·33 yards, or 6·21382 miles.

1 English Inch is equal to 25·39954 Millimetres.

OLD FRENCH LINEAL MEASURE.

				English Inches.
1 Douzième, or Point			=	0·0074
12 Points . . .	=	1 Ligne	=	0·0888
12 Lignes . . .	=	1 Pouce	=	1·065765
12 Pouces . . .	=	1 Pied	=	12·7892
1 Pied			=	324·7 Millimetres.

Official Standard Bushel, containing the legal Weight of Aq. Destillata, at 62° F., Barometer at 30 Inches, 80 lbs. Avoirdupois.

½ Bushel . . .	40 lbs. Avoirdupois.	Gill	5 ozs. Avoirdupois.
Peck	20 „ „	½ Gill	2½ „ „

January, 1870, ascertained error of Standard Bushel in Grains 83·343.

LIQUID MEASURES.

	Cubic Inches.	Grains of Distilled Water.
Imperial Gallon	277·274	70000
„ Pint	34·65925	8750
„ Ounce	1·7329625	437·5
Cubic Inch in Air, temp. 62° Fahrenheit, Barometer at 30 inches . . .	1	252·458
Ditto ditto in Vacuo, temp. 62° .		252·722
Cubic Foot, in Air, at 62°, 62·3206 lbs. avoirdupois.		
Litre	61·02525	15432·
Decilitre	6·10252	1543·2

Diameter of a Cylinder containing a Gallon, at one inch in depth, 18·78933 inches.

A Second of Time is the 86,400th part of a Mean Solar Day of 24 hours, and is used as the unit of Time.

A Degree of the Equator is 69·1613 miles, or 365,172 feet.

A Degree of the Meridian is 69·046 miles, or 364,565 feet.

A League is 3 miles.

A Fathom used in Sea Sounding is 2 yards, or 6 feet.

A Cable's Length is 120 fathoms, or 240 yards.

A Military Pace is 2½ feet.

The Portuguese Mile is 1·2786 English Miles.

The Legua (Spain) 8,000 Vara, or 22,256 feet, or 4·2152 miles.

The Swiss Meile is 26,666⅔ Fuss, or 8,548 Yards, or 4·8568 miles.

The Mil (Sweden and Norway) 6,000 Famn, or 11,690 yards, or 6·6423 Miles.

A Russian Verst or Werst is 500 Sachines, or 3,500 English Feet, or 0·6629 Miles.

A German or Saxony Post-meile is 24,000 fuss = 7,432 English yards, or 4·227 Miles.

Milan and Venice (New Decimal System of 1803.) 1 Miglio = 1000 Metri, or 1,093·63 yards, or 0·6214 Mile English.

Siam. 1 Vouah = 6·306 feet English, and the Roëneng = 2,000 Vouahs, or 12,612 Feet, or 2·3886 Miles English.

A Knot, or Nautical Mile, 6,082 feet.

An English Ordinary Mile, 5,280 feet, or 1760 yards.

A Geographical Mile, 6,080 feet.

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1 Cubic foot of fresh water weighs 62·425 lbs. = 557 cwt., or 0·028 of a ton.

1 Cubic foot of sea water weighs 64·11 lbs. = ·572 cwt., or 0·0286 of a ton.

1 Cubic inch of water weighs 0·03612 lb.

1 Cubic foot of water contains 6·24 gallons.

1 Ton of water contains 35·9 cubic feet or approximately 1 cubic metre.

1 Foot in head gives a pressure of 0·4335 lb. per square inch.

1 Inch of rain collected by an 8-inch circular gauge, = 29 oz. and 18 grains *weight:* 12-inch circular gauge, 58 oz. 36 grains.

Inches of rainfall multiplied by 2323200 gives cubic feet per square mile.

Ditto ditto by 14500000 gives gallons per square mile.

Ditto ditto by 3630 gives cubic feet per acre.

1 inch rainfall is approximately 100 tons 9 cwt. per acre.

Some experiments made at Kingston, Canada West, in February, 1854, gave a result that one cubic foot of Snow *as it falls* is equal to 288 cubic inches of water.

Snow (Virgin). 1 Foot cube or 1728 inches, weight 63 lbs. 14 oz. Taken up soon after falling, and compressed into a cubic vessel, temperature 19·50 Fahrenheit; dissolved at 52° Fahrenheit. Quantity of water yielded 1·728¼ cubic inches, and weight of water produced is 1021 oz., or 63 lbs. 13 oz.

Col. Sir H. James, R.E., 1860.

HORSE POWER OF STEAM ENGINES.

When Steam Engines were first introduced, they were commonly applied to work pumps or mills which had been previously wrought by horses. It was therefore convenient to be able to express the performances of these machines by comparison with animal power, to which miners and others had been accustomed. When an Engine was capable of performing the same amount of work in a given time as any given number of horses, such Engine was said to be of so many horses' power. This term having been long in use, it was retained it only being requisite to determine upon some standard by which it could be defined. The performance of a horse of average strength working for eight hours a day was therefore selected as a standard or unit of Steam Engine power.

Smeaton estimated the amount of mechanical effect which the animal could produce at 22,916 pounds raised one foot per minute. Desaguliers makes it 27,500 pounds raised through the same height. Messrs. Boulton and Watt caused experiments to be made with the powerful horses used in London breweries, and from the result of these they assigned 33,000 pounds raised one foot per minute as the value of a horse's power; this estimates is now generally adopted, and when an Engine is said to be of so many horse's power, it means that when in good working order, and properly managed, it is capable of overcoming a resistance equivalent to so many times 33,000 pounds raised one foot high per minute. Thus an Engine of 10-horse power should be capable of raising 330,000 pounds one foot per minute.

It being explained that one horse power expresses 33,000 pounds raised one foot high per minute, 1,980,000 pounds raised one foot high per hour, it is required to determine the quantity of water which a boiler must evaporate per hour for each horse power of the Engine which it works. The quantity of water requisite to produce this result by evaporation will be found by considering that one cubic inch of water evaporated will produce a mechanical force equivalent to 2,160 pounds raised one foot high. If we divide 1,980,000 by 2,160, it will give the number of cubic inches of water that must be evaporated per hour to produce the mechanical effect expressed by 1 horse power; the result of this division is 916, which is therefore the number of cubic inches of water per hour whose evaporation is equivalent to one horse power. In actual practice it has been customary for engineers to allow one cubic foot of water per hour for each horse power, a cubic foot being 1,728 cubic inches, or above 11 per cent more than the above estimate.

Another authority gives the following:—

One nominal horse power requires approximately	5 gallons of water per hour. 15 pounds of coal . . .	1 square yard of heating surface. 1 square foot of fire-bar surface.

In practice one pound of coal or coke should evaporate about five pounds of water.

The nominal horse power of a cylindrical double or single flued boiler may be found approximately by the following rule:—The length multiplied by the diameter, and divided by 5.

Water Pressure. Height in feet.	Pressure in cwt. per square foot.	Water Pressure. Height in feet.	Pressure in cwt. per square foot.	Water Pressure. Height in feet.	Pressure in cwt per square foot.	Water Pressure. Height in feet.	Pressure in cwt. per square foot.
1	·55	30	16·71	70	39·	150	83·6
5	2·78	35	19·5	80	44·5	175	97·5
10	5·57	40	22·3	90	50 1	200	111·
15	8·36	50	27·8	100	55·7	250	139·
20	11·14	60	33·4	125	69·6	300	167·
25	13·93						

1 Atmosphere equals 14·71 lbs. per square inch or about 15 lbs. approximately.
Ditto ditto 29·92 inches Mercury.
Ditto ditto 33·9 feet Water.

HEAT DISENGAGED DURING COMBUSTION.

Hydrogen Gas	34462	Wood, dry	4025	Tallow	8000
Marsh gas	13063	Wood, moist	3100	Diamond	7770
Olefiant gas	11858	Carbonic oxide	2400	Absolute Alcohol	7180
Oil of Turpentine	10852	Sulphur	2220	Phosphorus	5750
Olive oil	9860	Anthracite	8460	Bisulphide of Carbon	3401
Ether	9030	Charcoal	8080	Iron	1576
Coke	7000	Coal	8000		

The experiments of MM. Favre and Silbermann are the most trustworthy, as having been executed with the greatest care. They agree very closely with those of Dulong. Taking as thermal unit the heat necessary to raise the temperature of a pound of water through *one* degree Centigrade, the following table gives the thermal units in round numbers disengaged by a pound of each of the substances in burning in oxygen.

The experiments of Dulong, of Despretz, and of Hess prove that a body in burning always produces the same quantity of heat in reaching the same degree of oxidation, whether it attains this at once or only reaches it after passing through intermediate stages. Thus a given weight of carbon gives out the same amount of heat in burning directly to carbonic acid as if it were first changed into carbonic oxide and then this burnt into carbonic acid.

GANOT.

EXPANSION BY HEAT from 32° to 212° Fahrenheit :—

Mercury	0·0180180	Platinum	0·0008842 of the length.
Water	0·0433200 from 39° to 212°.	Flint Glass	0·0008117 „ „
Alcohol	1·1100 „ 32° to 174°.	Brass	0·0018708 „ „
Sulphuric Acid	0·0600		

Heat of a common fire 1141°; Wind Furnace White Heat, 3300°, is stated as its highest temperature.

Vital Heat, 98·4 Fahrenheit. See also page 138.

Heat borne by Delaroche 228° Fah. Highest Temperature borne by Sir Joseph Banks and Sir Chas. Blagden in a prepared heated chamber 264° Fah.; notwithstanding the extraordinary degree of heat to which the Experimenters were exposed for some considerable period, it is stated that the temperature of their bodies was not perceptibly raised. In some of the modern Turkish Baths Dry Air at a temperature varying from 250° to 300° Fah. is said to be used for short periods of time. Captain Nares and his companions in the Polar Expedition of 1875-76, state the *lowest Temperature* experienced was 62° below Zero of Fahrenheit's scale.

Mercury freezes, 37·9 Fah.—Kew. Carbonic Acid Gas Solid at 148° below. 0°, F.

Beneath the surface of the Earth the temperature *increases* at the rate of 1° Fah. for every sixty feet. Another authority states it 1° Fah. for every forty-nine feet. The temperature for the first sixty feet is influenced by the Seasons.

In deep caverns, the effect of the great heat of summer has been only felt at mid-winter and *vice-versa*, the cold of winter only reaches them at mid-summer.

See *ante* pages 31—146.

The Expansion or Contraction of Liquids heavier than Water (except Mercury) is about 1 degree (or 5 grains) for every 10 degrees of temperature above or below 60° F., varying slightly with the specific gravity of the liquid.

Water boiling at	212° Fahrenheit.
Alcohol	174°, variable with its Specific Gravity.
Mercury boils	660° „
Sulphuric Acid	590° „
A saturated solution of Sea Salt	218° „

Specific gravity of *fluid* Mercury. The density of this Metal at 39·2° F., is 13·588, according to Kupffer. Hence its Specific Gravity near the point of congelation will be 13·694.—MESSRS. PLAYFAIR AND JOULE.

The Specific Gravity of *solid* (frozen) Mercury is stated by Kupffer and Cavallo to be about 14·0.

According to Dufour, the Specific Gravity of Ice is 0·9178 ; Bunsen states it at 0·91674.

"Sea water freezes at $-2·5°$ to $-0°$ C. ; the ice which forms is quite pure, and a saturated solution remains. If water contains Alcohol, precisely analogous phenomena are observed ; the ice formed is pure, and all the Alcohol is contained in the residue."—GANOT.

"M. Despretz by the cold produced with a mixture of liquid Protoxide of Nitrogen, Solid Carbonic Acid, and Æther has reduced Alcohol to such a consistence, that the vessel containing it could be inverted without losing the liquid."

Lowest artificial cold produced by Chemical Combination, 187° below Zero F.—TAYLOR.
Ditto ditto 140° C.—GANOT.

INSTRUCTIONS FOR FIXING OR SETTING HORIZONTAL SUN DIALS.

It is most important that the plane upon which the Dial is to be fixed be truly horizontal and the North and South line be accurately ascertained. The surface of the Dial may easily be made parallel to the horizon or level, with the aid of a good Spirit Level, by testing its surface in at least three directions across its diameter.

To find the true Geographical North and South or Meridian line for the place, it is requisite to have a good Mariner's Compass and also to know the Variation of the Compass Needle for the locality at which the Dial is to be erected. For London the present variation is Westerly 19° 20′ at Kew, 18° 52′ Greenwich.

Now by the Compass bearings carefully mark off on the plane surface the true North and South points, and by them set the Sun Dial to correspond. This will then indicate Solar or True Time, which agrees with Mean Time (or that shown by a Clock) only on four different days in the year. To find the Mean Time it is necessary to apply a correction called the Equation of Time from a table which is mostly engraved upon the best constructed Sun Dials, or upon the Wooden Artificial Horizon of Terrestrial Globes.

A convenient season for setting Sun Dials by this method is about the time of the Vernal or Autumnal Equinox (March and September) when the Dial and Clock very nearly agree.

COMPASS VARIATIONS. *From "Mechanics' Magazine," March 16th*, 1865.
See also page 226.

	Days.	Minutes.	Yearly Rate of Change. Min.
1576	11	15	E . . . 7
1622	6	15	E . . . 11
1657	0	0	True North . 12
1672	2	30	W . . . 13
1720	13	0	W . . . 9
1765	20	0	W . . . 5
1819	24	41	W Max. W . 0
1852	22	18	W . . . 4
1865	20	38	W . . . 7

EQUATION TABLE.

JAN.	M	FEBY.		MARCH.		APRIL.		MAY.		JUNE.		JULY.		AUG.		SEPT.		OCT.		NOV.		DEC.	
1	Fast 4	1	Fast 14	1	Fast 13	3	Fast 3	1	Slow 3	4	Slow 2	4	Fast 4	10	Fast 5	4	Slow 1	3	Slow 11	15	Slow 15	2	Slow 10
3	5	21	13	3	12	7	2			9	1	10	5	15	4	7	2	7	12	20	14	5	9
6	6	27	12	7	11	11	1			14		21	6	20	3	10	3	10	13	24	13	7	8
8	7			11	10	15				20	Fast 1			24	2	13	4	14	14	27	12	9	7
10	8			15	9	20	Slow 1			24	2			27	1	16	5	19	15	29	11	11	6
13	9			18	8	24	2			29	3			31		18	6	27	16			13	5
16	10			21	7											21	7					15	4
19	11			25	6											24	8					17	3
22	12			28	5											27	9					19	2
27	13			31	4											30	10					21	1
																						24	
																						26	Fast 1
																						28	2
																						30	3

Fast means that the Clock should be faster than the Dial, Slow, slower. For fractional differences of Time consult the Nautical Almanack.

TABLE OF DIFFERENCE OF TIME BETWEEN GREENWICH AND THE FOLLOWING PLACES.

East of Greenwich.	Time Faster. H.	M.	S.
Algiers . .	0	12	16
Alexandria .	1	59	32
Athens (Greece)	1	35	0
Berlin . .	0	53	35
Bombay . .	4	52	0
Brindisi (Italy).	1	12	0
Brussels . .	0	17	30
Calcutta . .	5	54	0
Canton . .	7	33	0
Cairo . .	2	5	12
Cape of Good Hope	1	14	0
Christiana .	0	43	0
Constantinople .	1	56	0
Genoa . .	0	35	32
Geneva . .	0	24	37
Greenwich 12 o'clock noon . .	0	0	0
Jeddo . .	9	20	0
Madras . .	5	22	0
Manilla . .	8	4	8
Malta . .	0	58	0
Moscow . .	2	30	0

East of Greenwich.	Time Faster. H.	M.	S.
Munich . .	0	46	30
Naples . .	0	57	4
Paris . . .	0	10	0
Pekin . . .	7	46	0
Rome. . .	0	50	0
Rotterdam .	0	18	0
Singapore . .	6	56	0
Siam . . .	6	40	0
Suez . . .	2	10	16
Smyrna . .	1	49	0
St. Petersburg .	2	1	16
Venice . .	0	57	4
Vienna . .	1	5	30

West of Greenwich.	Time Slower. H.	M.	S.
Baltimore . .	5	6	27
Boston . .	4	44	14
Buenos Ayres .	3	53	28
Cape Horn . .	4	19	4
Chicago . .	5	50	31
Cincinnati . .	5	37	58
Dublin . .	0	25	0

West of Greenwich.	Time Slower. H.	M.	S.
Gibraltar . .	0	21	28
Havana . .	5	29	25
Jamaica, Kingston	5	7	4
Lima . . .	5	8	24
Lisbon . .	0	36	36
Madrid . .	0	14	0
Monte Video .	3	45	0
Mexico . .	6	36	20
New Orleans .	6	0	0
New York . .	4	55	0
Panama . .	5	18	0
Philadelphia .	5	0	34
Quebec . .	4	44	49
Rio Janeiro .	2	56	36
Savannah . .	5	24	21
Salt Lake City .	7	28	24
San Francisco .	8	9	47
Sydney . .	10	16	0
St. Thomas .	4	19	41
Toronto . .	5	17	34
Valparaiso . .	4	47	0
Vera Cruz . .	6	24	34

VELOCITY OF LIGHT.

In 1675 and 1676 Olaf Rœmer, a Danish Astronomer, first determined the velocity of Light from observations of the eclipses of Jupiter's first satellite as 192,500 miles per second.

Bradley at Kew, in 1723, determined the velocity of Light as 191,515 miles per second.

M. Foucault, by a modification of Wheatstone's revolving mirror, calculated the velocity at 185,177 miles per second.

M. Fizeau, at Paris, in 1849, by experiments carried on between Suresnes and Montmartre, found the velocity to be 194,677 miles per second.

More recent experiments by Foucault and Fizeau, 186,633 miles per second is stated.

By another experiment, the result is given as 196,000 miles per second.

VELOCITY OF SOUND.

The velocity of Sound is 1,125 feet in a second, at a temperature of 61° Fahrenheit, or 16·6 C.; therefore a distance of 50 miles would be traversed in 4 minutes.

In 1823, on two hills, Kooltjesberg and Zevenboomen, near Amsterdam, accurate experiments were made to determine the velocity of Sound by Moll and Van Beck. Making corrections for temperature, moisture, barometric pressure, and the action of the wind, the result of these experiments as corrected by Schröder Van der Kolk gives 1,092·78 feet as the velocity of sound per second in a dry atmosphere with the barometer reading 760 m.m., or 29·931 inches.

The velocity of sound increases with increase of temperature: this amounts to nearly two feet for every degree centigrade. For the same temperature it is independent of the density of the air, and therefore of the pressure.

VELOCITY OF ELECTRICITY.

"This is so great that the most rapid motion that can be produced by art appears to be actual rest when compared with it. A wheel revolving with a rapidity sufficient to render its spokes invisible, when illuminated by a flash of electricity, is seen for an instant with all its spokes distinct as if it were in a state of absolute repose; because, however rapid the rotation may be, the light has come and already ceased before the wheel has had time to turn through a sensible space.

"Let a circular piece of pasteboard be divided into three sections; let one be painted *blue*, another *yellow*, and a third *red*. Cause it to rotate rapidly, it will appear white, because a sunbeam consists of a mixture of these colours, and the rapidity of the motion causes the distinction of colours to be lost to the eye; but the instant the pasteboard is illuminated by the electric spark, it seems to stand still, and each colour appears as distinct as if the disc were at rest.

"By a beautiful application of this principle, Wheatstone contrived an apparatus by which he demonstrated that the light of the electric discharge does not last the *one-millionth part* of a second of time. His plan was to view the image of a spark reflected from a plane mirror, which, by means of a train of wheels, was kept in rapid rotation on a horizontal axis. The number of revolutions performed by the mirror was ascertained to be 800 in a second, during which time the image of a stationary point would describe 1,600 circles, because from the laws of reflection the image of an object in a revolving mirror has *twice the angular velocity* of the latter, and the elongation of the spark through half a degree would indicate that it exists $\frac{1}{152\cdot000}$th part of a second. A jar was discharged through a copper wire half a mile in length, interrupted both in the middle and also at its two extremities, so as to give three distinct sparks. The deviation of half a degree between the two extreme sparks would indicate a velocity of 576,000 miles in a second. This estimated velocity is on the supposition that the electricity passes from one end of the wire to the other; if however, according to the *two fluid* theory, the two electricities travel simultaneously from the two ends of the wire, the two external sparks will keep their relative positions, the middle one alone being deflected, and the velocity measured will be only one-half that in the former case, viz., 288,000 miles in a second."

There are, however, great discrepancies in the different measurements which have been recorded of the velocity of Electricity, thus:—

Walker (America) with telegraph Iron wire, makes it	18,780	miles	per second.
O'Mitchell (America) „ „ „	28,524	„	„
Fizeau and Gonnelle, Copper Wire, make it .	112,680	„	„
„ „ Iron Wire „ . .	62,600	„	„
* Astronomers of Greenwich and Brussels, Copper, London and Brussels telegraph, make it .	2,700		
Astronomers of Greenwich and Edinburgh, Copper, London and Edinburgh telegraph, make it .	7,600		

NOAD.

* *Athenæum*, January 14th, 1854.

OHM'S LAW.

Ohm assumed the passage of the electric fluid from one section to another of the connecting wire to be due solely to the difference of electric tension between the two seetions; he further assumed the quantity of electricity transmitted to be proportional to this difference of tension, and from these fundamental assumptions he deduced the laws of the voltaic circuit. These laws may be briefly stated thus :—

a. The strength of the current is directly proportional to the electromotive force.

b. The strength of the current is inversely proportional to the resistance.

c. If the wire which unites the two poles of battery be of the same material, and of the same thickness throughout, the "electric fall" is the same throughout the wire.

d. If the wire be of the same material but of different thicknesses, the "fall" is steeper on the thin wire than on the thick. The "fall" is inversely proportional to the cross section of the wire.

e. If the poles be connected by two wires of the same thickness but of different resisting powers, the "electric fall" is steeper on the more resisting wire. The "fall" is directly proportional to the specific resistances of the wires.*

* See Tyndall's *Notes on Electricity*.

It has been found that when the same current is passed respectively through a short and through a long wire of the same material, its action on the magnetic needle is less in the latter case than in the former. Ohm accordingly supposed that in the latter case there was a greater *resistance* to the passage of the current than in the former; and he proved that "*the resistance is inversely proportional to the intensity* of the current.

On these principles Ohm founded the celebrated law which bears his name, that—

The intensity of the current is equal to the electromotive force divided by the resistance.

Which is expressed by the simple formula

$$I = \frac{E}{R}$$

Where I is the intensity of the current, E the electro-motive force, and R the resistance.†

† See Ganot's *Elementary Treatise on Physics*.

ELECTRIC UNITS.

The *Unit of Resistance* is

1 Ohm = 1 British Association Unit = 1 B. A. U. = 10 Million Units of resistance, or :

1 Siemen's Unit = 1 S. E., the resistance of a prism of mercury, 1 metre long, and 1 square millimetre in section at 0° C.

1 Ohm = 1·070 S.E.

1 S.E. = ·935 Ohm.

1 Meghom = 1 million Ohms.

The *Unit of Tension* is = 1 Volt = 100,000 Units of Tension.

The *Unit* of Quantity = 1 Weber.

The Unit of Charge is = 1 Microfarad = 1 Millionth part of a Farad.†

† *Electric Testing of Telegraph Cables*. By Capt. V. Hoskiær, Royal Danish Engineers.

1 Ohm = about one mile of Copper Wire. No. 16 B. W. Gauge ; or 1 mile of No. 8 Iron Wire, B. W. Gauge—a Rough definition by a Workman.

The laws of the voltaic circuit as ennunciated by Ohm have been verified by Kohlrausch and others, and found to be in strict accordance with his theory.

THERMOMETER SCALES.

The Zero of the Centigrade and of Reaumur's Thermometer each correspond to 32° Fahrenheit.

To convert degrees of Reaumur into equivalent degrees of Fahrenheit, multiply the degrees of Reaumur by 9, divide the product by 4, and add 32; the result will be the degrees of Fahrenheit. 9 Fahrenheit, 5 Centigrade, and 4 Reaumur are equivalents. In Wedgwood's Pyrometer the Zero commences at 1·077° Fahrenheit; and each degree, instead of being equal to 130° of Fahrenheit, as was supposed by its maker, is only equal to about 20°.

Easy Rules for the Reduction of Scales.

To convert Reaumur into Fahrenheit, multiply by 2·25 and add 32°.

To convert Centrigrade into Fahrenheit, multiply by 1·8 and add 32°.

Histoire du Thermomètre. Par M. E. Renou. Excerpt from the *Annuaire de la Société Météorologique de France*, 1876.

The following lines are from the author's introduction.

"The history of the thermometer has been written many times, but always either so incompletely or so inexactly that one may say its history has still to be written. This it is which has induced me to publish the results of my long researches."

"M. Renou states his resons for believing that neither Cornelius Drebbel nor Santorio (often wrongly called Sanctorius) used thermometers, but merely open-ended thermoscopes, and that Galileo appears to have been among the earliest (about 1613) to apply any scale to the thermometric tube. After paying a high tribute to the skill of the Cimento Academicians, and mentioning La Hire's journey to Florence and the subsequent construction of a thermometer in Paris by Hubin, he states that Robert Hooke, in his *Micrographia*, published in 1667, was the first to describe a thermometer with one point of its scale (the freezing point of water) properly fixed. All these thermometers were filled with alcohol. Priority as to the idea of employing mercury is assigned to Halley, in consequence of his paper in the *Philosophical Trans.*, 1693; and he is also credited with regarding the temperature of boiling water as fixed. (Approximately of course; we now know that it varies with the barometric pressure.) Almost simultaneously, Renaldini, a professor at Padua, thought of using this boiling-point temperature as the means of fixing the upper point of the thermometric scale, just as the melting of ice had been for the lower. Subject to refinements, these are the points still used. A few paragraphs are devoted to the efforts of La Hire, and his experiments upon the temperature of the caves of the Paris Observatory, and then reference is made to Sir I. Newton's paper in the *Philosophical Trans.*, 1701,* wherein M. Renou states that he finds the earliest indication of the temperature of the human blood, although usually it has been attributed to Boerhaave; and in the same page he demolishes the pretended discoveries of Amontons, and shows that they had all been previously made by Halley, Renaldini, and Newton. After a carefully written notice of the life and labours of Fahrenheit, and also of De Luc, M. Renou winds up the first part of his paper with three paragraphs, which show clearly the error of regarding Celsius' thermometer and the Centigrade thermometer as identical. We translate the leading facts.

"In 1742, Celsius, a learned Swede, designed a Mercurial thermometer, of which 0° was at boiling point and 100° at freezing point. This was not the true Centigrade thermometer, and they are wrong in Germany in calling the Centigrade thermometer the thermometer of Celsius.

"It is indisputable that the Centigrade thermometer is due to Linné; the fact is shown by a letter from this illustrious man, quoted by Arago, T. V. p. 608, and M. Hildebrandsson, of Upsala, assures me that Linné's title to the invention is indisputable."

"The third section of the work is principally devoted to a history of the various modes adopted for determining the boiling point, and it is shown that Cavendish, in 1777, was the first to indicate the proper method.

* Linseed Oil was the fluid used by Sir I. Newton in one of his experimental Standard Weather Range Thermometers, R. W.

"The fourth section deals with the shifting of the zero point, and by a series of quotations, shows (1) that Flaugergues, of Viviers, was the first to observe the fact; (2) that Bellani was the first to announce it as a necessary result of the contraction of the glass; and (3) that the general publication of the fact is due to Pictet, of Geneva. M. Renou rather neatly demolishes the suggested claim of Arago to the discovery, by putting in juxtaposition two statements by Arago on the subject.

"In section five M. Renou discusses the precise conditions under which the boiling point should be fixed; he approves generally of those adopted by the English Royal Commission, but suggests a slight modification in the third term of the formula.

"Section the sixth is devoted to special forms of thermometer, and section the seventh principally to thermometers employed for hypsometric purposes and as measures of solar radiation.

"Section eight treats of registering thermometers; the rather impractical ones proposed by Bernouilli in 1693 are mentioned first, then those of Cavendish, Six, Rutherford, and Phillips.

"It is with reference to this last thermometer—Phillips' Maximum—that M. Renou has made almost the only mistake in his excellent and singularly impartial paper; viz. ascribing its invention to M. Walferden.

"A single reference to a work which is probably in M. Renou's library, certainly in that of the Institute, will settle the point; viz., *Second Report of the British Association*, 1832, p. 574,* where will be found 'Description of a new Self-registering Maximum Thermometer, by John Phillips, F.G.S.'

"Chapter IX. gives a short but very accurate history of metallic thermometers, from their invention by Musschenbroek to the present time. Johnson's pattern appears to be unknown to M. Renou.

"Self-recording thermometers are discussed in Chapter X., but much more briefly than other forms; Van Rysselbergh's apparatus is warmly commended.

"The eleventh and last chapter is introduced by the following words: "Arrived at the end of our task, we may ask ourselves: What is the present state of thermometry? what are the developments which still await it? and what is its future?" In reply M. Renou points out the necessity of determining the co-efficient of the cubical expansion of the glass used for thermometer tubes, and the desirability of comparing alcohol and air thermometers at very low temperatures."

This article is condensed from a Review of M. Renou's book written by G. J. Symons, Esq., and published by him in his monthly *Meteorological Magazine*, for January, 1877, to which we refer our readers for further interesting facts.

Table of Mean Winter Mean Summer and Annual Mean Temperature Fahrenheit Scale.	Winter Mean Tempt.	Sum. Mean Tempt.	Annual Mean Tempt.	Table of Mean Winter Mean Summer and Annual Mean Temperature Fahrenheit Scale.	Winter Mean Tempt.	Sum. Mean Tempt.	Annual Mean Tempt.
London . . .	39·5	63°	51°	Batavia . . .	79	81	80.5
Dublin . . .	40	66·5	49	Madras . . .	76·5	86	82
Edinburgh . .	38·5	58·	47·5	Rio Janeiro . .	68·5	79	73·5
Paris . . .	38	64·5	51·5	St. Croix (Teneriffe)	64·5	77	71·5
Rome . . .	46.5	73.	60	Monte Vidio . .	57·5	77·5	67
Naples . . .	50	75·5	62	Buenos Ayres . .	52·5	73	62·5
Gibralter . . .	57	73	64·5	Mexico . . .	55·5	66·5	62
Berlin . . .	30	63	47·5	Algiers . . .	54·	74·5	64
Stockholm . .	26	61	42	Nangasaki . .	47·1	81·8	64.9
Warsaw . . .	27·5	63·5	45 5	Cape of Good Hope	58·5	74°	66.5
New Archangel .	33	55	44·5	New Orleans . .	53	80	67
Constantinople .	40·5	73·5	57	Montreal . .	17·5	69	44
Madrid . . .	42	74	58	Toronto . . .	26·5	63·8	44·4
Cairo . . .	58·5	84·5	72·5	Penzance . .	44	62	52
Calcutta . . .	67·5	83·5	78·5	Pekin . . .	26	83	55
Bombay . . .	74	83	79	Quito . . .	60	60	60
Singapore . .	78·5	81	80·5	Canton . . .	55	82	70

Professor DANIELLS.

* In another edition, p. 580.

INDEX.

The figures in this Index refer to the numbers on the margin of each page of the Catalogue, unless the page be indicated.

ADDENDA.

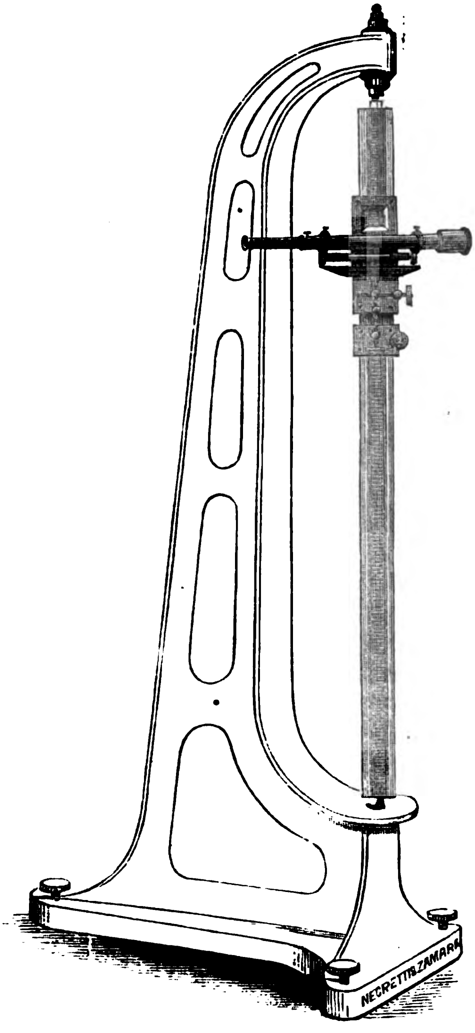

FIG 1A.

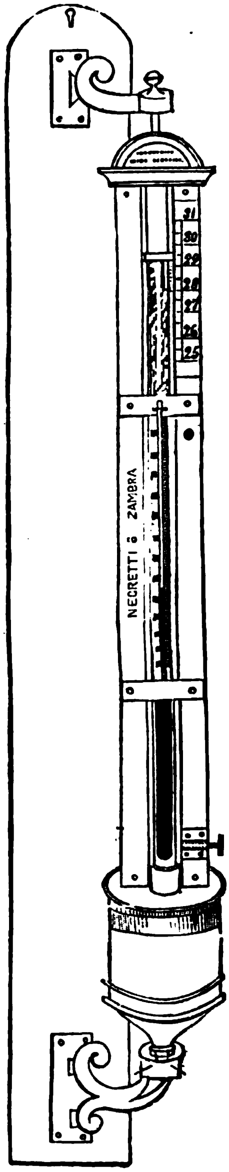

FIG. 2A.

Fig. 1A. **Cathetometer.** Improved arrangement, suited for Observing Stations of the First Class. Price £50 to £30; varying with the fineness and accuracy of the divisions and the number of adjustments attached to the Instrument. See also page 8, No. 10.

Fig. 2A. **Observatory Standard Barometers,** of the highest class, suitably mounted for being read off with the Cathetometer. Price £20, £25, and £35. See also page 8.

FIG. 3A.

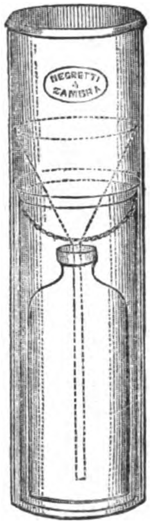

FIG. 6A.

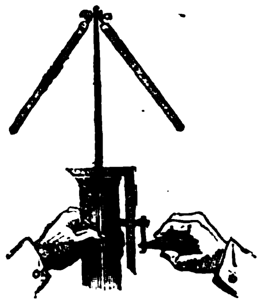

FIG. 4A.

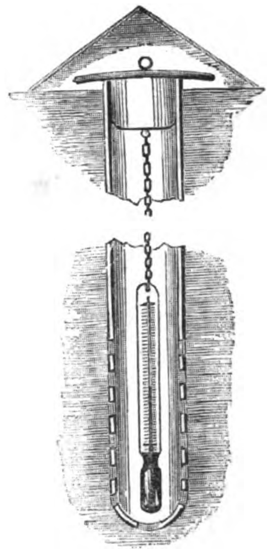

FIG. 5A.

Fig. 3A. **Negretti and Zambra's Students' Standard Barometer.** In laying off and dividing the scale of this instrument, allowances have been made to compensate for the ordinary rise and fall of the mercury, making it sufficiently accurate for observers who do not wish to incur the expense of Fortin's arrangement for adjusting to a Zero Point. Price £4 15s.

Fig. 4A. **Babinet's Apparatus** (or Thermometer Fronde), for ascertaining the temperature of the Air by the rapid rotation of two sensitive Thermometers. Price with Thermometers, £2 10s.

Fig. 5A. **Earth Thermometer,** Symons' Tubes arrangement, with Negretti and Zambra's Slow Action Thermometer. (See No. 371, page 146.) An iron tube closed at the lower end to be forced down into the earth, and secured at the desired depth, and the Thermometer lowered down into it by a cord or chain to the bottom, and allowed to remain a sufficient time; when the temperature is to be noted, it is quickly drawn up and its indication observed. The great advantage of this method of obtaining Earth Temperatures is that the Thermometer can at any time be *compared with a Standard,* which is a difficult if not almost impossible operation to be carried out with Thermometers of great length.

Supplied to Order; for probable cost, see pages 30 and 146.

Fig. 6A. **Symons' Snowdon Rain Gauge.** This is a 5-inch gauge, fully described No. 90, page 62. Price in Galvanised Iron, 12s. 6d.; with Mr. Symons' Certificate, 15s.